CANADIAN AGRICULTURE LIBRARY
AGRICULTURE AND AGRI-FOOD CANADA
CENTRAL LIBRARY
BIBLIOTHEQUE CENTRALE
EDIFICE SIR JOHN CARLING BLDG.
OTTAWA, ONTARIO
CANADA K1A 0C5
BIBLIOTHEQUE CANADIENNE DE L'AGRICULTURE

WINTER 73
HIVER 73

CANADA AGRICULTURE

Even distribution of formic acid to grass silage may be the answer to higher quality forage and greater energy intake by cattle in the Great Clay Belt. See story page 3.

Une égale répartition de l'acide formique sur l'ensilage d'herbe peut être la solution pour augmenter chez les bovins de la ceinture argileuse la consommation de matières énergétiques et améliorer la qualité du fourrage. Voir article page 3.

CANADA AGRICULTURE

AGRICULTURAL POTENTIAL AT KAP — 3
DAYLIGHT INSENSITIVE OATS — 7
AVOINE INDIFFÉRENTE À LA LONGUEUR DU JOUR — 7
COOPERATION IN DEVELOPING WHEAT VARIETIES — 10
SOIL ACIDITY AND POTATO PRODUCTION — 12
FORAGES FOR PEACE RIVER ACID SOILS — 15
ALFALFA WEEVIL—BLESSING IN DISGUISE? — 16
ECHOES / ÉCHOS — 18
TRENDS IN PRICES AND QUANTITIES BOUGHT IN FARMING — 20
POTATO WART RESEARCH IN NEWFOUNDLAND — 23
ICE SHEET INJURY AND FORAGE CROPS — 26
WHITE MOLD EPIDEMICS IN WHITE BEANS — 28
TREFLAN CONTROLS WEEDS IN RAPESEED — 30
SELECTING PRODUCTIVE HAY MIXTURES — 32
GRAIN STORAGE PROBLEMS — 33

VOLUME 18 WINTER 1973 NO. 1
VOLUME 18 HIVER 1973 N° 1

JOURNAL OF THE CANADA DEPARTMENT OF AGRICULTURE—OTTAWA
REVUE DU MINISTÈRE DE L'AGRICULTURE DU CANADA—OTTAWA
MINISTER, HON. EUGENE WHELAN, MINISTRE   DEPUTY MINISTER, S. B. WILLIAMS, SOUS-MINISTRE

CANADA AGRICULTURE is published quarterly to inform extension workers and agri-businessmen of developments in research and other federal agricultural responsibilities.

Any article may be reproduced without special permission provided the source is given credit. If excerpts only are to be used, authors' permission should be obtained.

Reprinted articles must not be associated with advertising material. The use of trade names published in this journal implies no endorsement of the products named nor any criticism of similar products not mentioned.

Contributors may submit articles in either English or French to the Secretary, Editorial Board, Information Division, Canada Department of Agriculture, Ottawa.

La revue trimestrielle *CANADA AGRICULTURE* renseigne les vulgarisateurs et représentants du négoce agricole sur les développements de la recherche et des autres services agricoles du gouvernement fédéral.

La reproduction des articles est permise en indiquant l'origine. Pour reproduire des passages d'un article, l'autorisation de l'auteur est nécessaire.

Les articles reproduits ne doivent pas servir à des fins de réclame. La mention de marques de fabrique ne signifie pas que la revue garantit ces produits ni qu'elle déconseille d'autres produits non mentionnés.

Les articles en anglais ou en français doivent être adressés au secrétaire du Comité de rédaction, Division de l'information, ministère de l'Agriculture du Canada, Ottawa.

EDITORIAL BOARD

COMITÉ DE RÉDACTION

G. M. Carman
Chairman Président
J. W. Morrison
C. R. Phillips
R. J. McClenaghan
J. F. Frank
J. J. McConnell
C. H. Kenney
D. W. MacDonald
Secretary Secrétaire

Editing / Rédaction
D. W. MacDonald
G. J. Lempereur
D. M. Guertin

Graphic Design / Graphique
A. J. McAllister


About 2,000 tons of grass silage are stored annually in 10 concrete-based bunker silos.

UNLOCKING THE AGRICULTURAL POTENTIAL AT KAP

À la Ferme expérimentale de Kapuskasing, Ont., la Station de recherche d'Ottawa et l'Institut de recherche zootechnique ont combiné leurs efforts pour résoudre les problèmes menant à l'établissement d'un système de protection du bœuf pour la région située dans la grande enclave argileuse.

D. W. MacDONALD

The Great Clay Belt of western Quebec (Abitibi) and northern Ontario has to be one of the largest untapped agricultural resources in North America. Twenty-nine million acres of deep arable land lie crescent-shaped, and relatively idle from the standpoint of agricultural production, along the 50th parallel south of James Bay. Deposited originally by a glacial lake, the land mass is an undulating plain of clay, sometimes imperfectly drained, with low lying boggy areas, as well as stretches of light sandy soil.

Cleared of forest, the Great Clay Belt is not unlike the parklands of western Canada. It varies from slightly acid in Ontario to strongly acid in Quebec.

The Great Clay Belt represents a challenge in resource development. The Canada Department of Agriculture accepted this challenge years ago when it established an experimental farm at Kapuskasing in 1914 to demonstrate the agricultural potential and find answers to production problems in this unique region.

About 2.5 million acres of the Great Clay Belt have been cleared for farming since settlers followed the trans-continental railway through the area over 50 years ago. Much of the farmland has since been abandoned. Only on the Quebec side does agriculture remain of some importance.

Much of the land in Ontario is crown-owned, and the wood products are used for pulp and paper. But it can be cleared at a cost of $60 to $135 an acre for agriculture.

What is the future of this expanse of arable land? Will land costs and other factors in established beef producing areas make operations in the Great Clay Belt more competitive?

EXPANSION IN BEEF

It has been estimated that by 1980, the number of cattle in Canada will increase to about 16.5 million head, a one-fifth increase over the present number. Some of the increase will undoubtedly take place in western Canada. Will the more humid regions in the east, such as the Great Clay Belt play a role in this expansion?

Cleared land at Kapuskasing has a carrying capacity, depending on rainfall, that varies from .7 beef animal per acre in June and July to about .5 in August and .2 in September. About 375 pounds of liveweight gain per acre have been produced on Kentucky bluegrass, creeping red fescue and wild white clover. Seventy per cent of the gains were made in June and July, 16 per cent in August and only 6 per cent in September.

Research at Kapuskasing indicates that much higher yields are possible under intensive care and management. Oat yields of 150 bushels and 5.5 tons of forage dry matter have been recorded, using fertilizer with normal rainfall. Over 650 pounds of liveweight gain per acre in beef cattle could be produced under intensive management.

Highest rainfall occurs during the harvest months of July, August and September, when an average of

Mr. MacDonald is Head, Periodicals Services Unit, CDA Information Division, Ottawa.

Forage makes lush growth in the Great Clay Belt.

The Shorthorn herd at Kapuskasing is being crossed with Limousin to affect rate of gain.

3.2 inches falls each month. Rains are frequent, which makes crop drying and field operations difficult. Harvesting losses in the form of low quality forage, as well as damp grain and inability to operate machinery at the right time have been major factors limiting agricultural production in the region.

Reorganization of the Canada Department of Agriculture in 1964 resulted in the farm at Kapuskasing being amalgamated with the Ottawa Research Station. Resources of the farm were committed to a study of the economics of beef production. Under Superintendent J. E. Comeau, emphasis changed from conventional dry hay-grain systems for dairy cattle to grass silage for beef. Research on beef cattle was undertaken in cooperation with scientists at the CDA Animal Research Institute, Ottawa. The ARI shorthorn herd was moved from Ottawa to Kapuskasing at that time.

HOME GROWN FEED

Today, under Superintendent J. M. Wauthy, 300 head of beef are over-wintered at Kapuskasing, and 500 during the pasture season. The stock is still mainly Shorthorn, however some are being bred artificially to Limousin bulls to achieve faster growth characteristics. Except for 100 tons of hay purchased for muscular dystrophy studies, as well as mineral and protein supplements, all feed is produced on the farm.

FORAGE AND CEREAL CROPS

Legumes can be grown, but on low ground they cause management problems. Timothy, reed canarygrass and brome give highest yields of forage dry matter according to Mr. Wauthy. Three tons per acre in two cuts are possible and profitable. Nitrogen fertilizer (75 pounds in spring, and 75 pounds after first cut) is important not only from the standpoint of increased yield, but higher protein as well.

Because of it's high yield potential, and it does well on poorly drained soils, reed canarygrass is being added to grass silage mixtures. When mature, this grass is known to be coarse and unpalatable. However when cut early, and stored as silage, it is highly digestible and palatable to cattle Mr. Wauthy finds. As it has to be harvested earlier than other grasses, it will lengthen the harvesting season.

If locally grown grain is to play an important role in feed energy requirements of beef production in the clay belt, early seeding will be a key factor in advancing the date of harvest and improving yields. (Table 1 shows effect of early seeding on yield of grain). To avoid delays Mr. Wauthy has even practiced frost seeding. Promising results have been achieved by working the seedbed in the fall, and seeding in spring when there is still sufficient frost in the ground from low night temperatures to support seeding equipment, but soft enough on the surface to be able to cover the seed.

TABLE 1. EFFECT OF EARLY SEEDING ON GRAIN YIELD

		2 Year Average lbs./acre		
Species		Late April	Mid-May	Early June
Oats:	Dorval	3790	2990	2134
	Garry	3681	3195	1804
	Russell	3423	3000	1783
Barley:	Herta	3639	2934	2227
	Keystone	3323	2931	2541
	York	2883	2472	2409
Spring Wheat:	Selkirk	3089	2562	1867
	Pembina	3002	2526	1809
	Manitou	2871	2563	1825

WORKABLE COMBINATION

Feed, shelter and other management factors all contribute to the cost of beef production. One has to find a workable combination for conditions in a particular area if the enterprise is to be attractive and competitive with other areas. CDA scientists are finding answers to some of the local problems with a view to putting everything together in the most economical system.

Work at Kapuskasing by Dr. E. E. Lister and Mr. W. A. Jordan, CDA Animal Research Institute, Ottawa, has determined that pregnant beef cows will overwinter quite readily without shelter and produce a healthy calf. Cows wintered in open pens however require 30 per cent more feed from September to March than cows in an insulated barn. In planning a system, producers have to balance the extra cost of feed against the cost of shelter.

Cold barns (not insulated) of the pole type have not been ideal because of ventilation problems, and the difficulty of managing the manure pack both inside and outside in adjoining yards. Under confinement, manure presents quite a problem because it freezes under some conditions. During wet spells and spring break-up, manure packs flow with the tide, posing a potential pollution problem, and making it difficult to manage and return to the fields. Shavings that have been used as bedding because they are readily available, but they add considerably to the cost, and create fertility problems when returned to the land with the manure.

COST FACTORS

Insulated barns with controlled ventilation, and slatted floors with a manure pit are considered workable and convenient from the standpoint of labor and handling, but the cost has to be balanced against the saving in feed, labor, bedding, control of manure run-off, manure handling, as well as any improved performance and health of the cattle. Calving time can be managed better under sheltered conditions. Difficulties arise under a continuous confinement system, the Animal Research Institute scientists have found, when cows fail to consume sufficient energy from silage to nurse their calves satisfactorily.

Increasing the intake of energy from forage is the big problem for the nutritionists. The energy is there, in large quantities, in the form of forage. The question is, can it be harvested and stored in a highly digestible condition to promote profitable gains and maintenance of cattle. Too often forage has been of low digestibility and cattle have not been able to consume enough for rapid gains or milk production plus maintenance. Can the quality be improved?

The first step according to Dr. J. R. Lessard, also of CDA Animal Research Institute, Ottawa, is to cut forage early (pre-bloom stage) when energy and protein are in their most digestible form. However, cutting is often delayed by the weather. And once cut, forage harvesting can be further delayed because of wet conditions. Losses of feed value occur due to weathering.

EARLY CUT FORAGE

At Kapuskasing, scientists are trying to obtain over 60 per cent average digestibility for the 2,000 tons of silage harvested annually. Weather conditions make this impractical under a wilted silage system. Dr. Lessard believes it has to be as high as that if grass silage is to provide sufficient energy intake from forage. The best way to achieve high energy grass silage under adverse conditions prevailing in the clay belt he says, is direct-cut, high moisture (20 to 30 per cent dry matter) silage, stored in bunker silos. Preferably, the crop should be cut and blown into the wagon in one operation. Too many things can happen to spoil the quality if left to wilt (30 to 40 per cent dry matter) in the field. Ensile immediately, Dr. Lessard suggests, and cover quickly (daily) with sheets of polyethelyne to exclude air. Packing is not necessary in bunker silos provided the silage is sealed tight, to avoid entry of fresh air.

Many farmers rejected high moisture grass silage years ago because of odors of butyric acid and run-off. Cattle performance wasn't entirely satisfactory on high moisture silage because they couldn't consume enough for economical gains or maintenance. Intake was subsequently improved with wilted silage. However, wilted silage is subject to more exposure, and requires better management. In view of the circumstances, Dr. Lessard feels direct-cut, high moisture silage is more adapted to conditions in the clay belt, and particularly since the advent of formic acid preservatives. With formic acid, cutting need not be delayed because of the weather, and it improves the digestibility and intake of the crop.

Formic acid eliminates the smell of butyric acid as well, he states.

See table (next page) showing intake and performance of cattle on treated forages.

HIGH INTAKE

Best intake and gains were secured from silage treated with 4 pounds of formic acid. Higher rates would be required if there are legumes in the mixture, or if it is not evenly distributed. Methods of applying formic acid still have to be improved.

Formic acid costs about 20 cents a pound. At 12 pounds per ton, treatment becomes rather expensive. But 4 pounds was effective and reduced the cost to a point where this preservative could play a major role in improving the quality of forages in the clay belt.

If beef producers are to take full advantage of the soil resources of the Great Clay Belt by finishing cattle to market weight, higher energy feeds will have to be available. There is potential for high moisture

TABLE 2. EFFECT OF DIFFERENT FORAGES ON INTAKE AND GAINS Comparison of Different Feeds and Consumption for a 68 Day Period Starting with Heifers at 630 lbs.

	Unpacked grass silage			
		Direct Cut & Formic Acid		
	Wilted	4 lb.	8 lb.	12 lb.
No. of Calves	9	9	9	9
D.M. %	45.3	30.9	29.0	27.1
D.M. Consumption per day per calf	21.4	22.8	21.2	19.8
Gain per day (lbs.)	1.03	1.72	1.60	1.36

Beef cows have over-wintered and reared their calves in this type of feedlot at Kapuskasing.

grain, and high energy whole plant barley silage production. A carlot of steers raised at Kapuskasing was shipped to the Toronto market recently. They had gained about 2 pounds per day from weaning on all the whole plant barley silage they would eat, plus one pound of high moisture barley grain per day for every 100 pounds in weight.

Forages grown in the Great Clay Belt often contain less than .1 ppm of selenium because of soil deficiencies. This triggers a high incidence of nutritional muscular dystrophy or white muscle disease in beef cattle. Dairy cattle are affected to a lesser extent because they are fed more grain from areas where selenium is not deficient. Cattlemen achieve some control by injecting animals with Vitamin E and selenium. But selenium can only be administered on a prescription basis, and this type of emergency cure has been rather expensive. Research by Dr. K. J. Jenkins and Dr. M. Hidiroglou, CDA Animal Research Institute, Ottawa, has proved that the deficiency disease can be prevented conveniently and economically by adding selenium and Vitamin E to salt blocks or mineral feed mixtures so that cattle consume small amounts all the time. Neither selenium nor Vitamin E is required in such large amounts when they are combined and fed together. There is a genuine saving in the cost of prevention. However, use of selenium in livestock feeds to prevent nutritional muscular dystrophy in Canada has not yet been approved.

Research on the disease in the Great Clay Belt has been aided by the extension and development work of Dr. J. Proulx, a veterinarian with the Ontario Ministry of Agriculture and Food, stationed at the Experimental Farm, Kapuskasing.

At Kapuskasing, CDA nutritionists have found that beef cows maintained on a 50% ad libitum ration of hay or grass silage during the winter feeding period showed a depression in blood plasma magnesium levels and were therefore susceptible to magnesium tetany or grass staggers. To avoid this disease, Dr. Lister, and his associates recommend the addition of 15 per cent of magnesium oxide to the free choice mineral supplement if forage is the only source of feed for beef cows, and particularly if it is restricted in quantity to prevent cows gaining excess weight. A 15 per cent magnesium oxide supplement should also be available to cattle going onto young lush pasture.

WINTERING PREGNANT BEEF COWS

Research at Kapuskasing has also determined that wintering pregnant beef cows fed grass silage exclusively as a maintenance ration progressively lowers the blood copper levels compared with those fed hay only. The same condition can occur in cattle pastured on lush grass due to the formation of a cooper-sulphur complex in the rumen, reducing the amount of copper available for metabolic function.

CDA nutritionists recommend the addition of 0.5 per cent copper sulfate to the salt mixture if grass silage is the only feed source in areas with high molybdenum and high sulfate soils which will reduce copper availability to forage plants.

Having become involved with many of the factors that contribute to beef production in the north, from crop management to feeding and care of the animals, CDA scientists working at Ottawa and Kapuskasing have come to the point where they can put their findings together in an all over-all system that will be most adaptable and economical in relation to the resources and circumstances of the region. ■

DAYLENGTH INSENSITIVE OATS

Dr. Burrows examines seed set on oat hybrid exposed to 14 hours of daylight in Ottawa growth chamber.

AVOINE INDIFFÉRENTE À LA LONGUEUR DU JOUR

M. Burrows examine des plants d'avoine hybrides après 14 heures d'exposition à la lumière du jour dans le phytotron d'Ottawa.

V. D. BURROWS

Canadian plant breeders commonly grow two wheat, barley or corn crops a year—a summer crop in Canada and a winter crop in California, Mexico or Florida.

Two annual crops have not been possible with Canadian oat varieties because oats require "long-day" photoperiods for proper flowering behavior. They are said to be sensitive to daylength: meaning that the number of days required for flowering is reduced considerably as daylength exposure is increased over rather narrow increments from 12 to 24 hours. Breeders are unable to grow Canadian varieties such as Rodney, Harmon, Dorval or Stormont in California to produce seed in sufficient quantity and in time for spring planting in Canada. This inability to grow two crops a year in the field has seriously hampered plant breeding efforts in oats.

Fortunately this problem is well on its way to solution because of research work being conducted by members of the Ottawa Research Station both at Ottawa and at the U.S.D.A. Southwestern Irrigation Field Station at Brawley, California. (Responsibility for the operation of the winter cereal nursery at Brawley resides with Dave Mallough and Glen Boughton of the Research Station at Regina, Sask.). Several daylength insensitive strains possessing desirable agronomic traits and the proper maturity characteristics will be available for widespread testing in Canada, in 1973.

Dr. Burrows is Chief, Cereal Crops Section, CDA Research Station, Ottawa.

Au Canada, les améliorations de plantes produisent généralement deux récoltes de blé, d'orge ou de maïs par année—une en été au Canada et une autre en hiver, en Californie, au Mexique ou en Floride.

Jusqu'à maintenant, la même chose n'a pas été possible avec les variétés canadiennes d'avoine, car celles-ci exigent des jours longs pour fleurir. On dit qu'elles sont sensibles à la photopériode, c'est-à-dire que le nombre de jours nécessaires à la floraison est considérablement abaissé à mesure que la longueur du jour augmente, par accroîts relativement petits, de 12 à 24 heures. Ainsi en Californie, les sélecteurs ne peuvent obtenir des variétés canadiennes comme Rodney, Harmon, Dorval ou Stormont, pour assez de semences ni assez tôt pour les semailles du printemps au Canada. Cette impossibilité d'obtenir deux récoltes en pleine terre par année a considérablement entravé les travaux d'amélioration de l'avoine.

Heureusement, cette difficulté est en voie de se résoudre grâce aux travaux effectués par les chercheurs de la Station de recherches d'Ottawa, tant à Ottawa qu'à la Station expérimentale d'irrigation du sud-ouest du ministère de l'Agriculture des États-Unis à Brawley (Californie).

La conduite des recherches à la Station de Brawley a été confiée à MM. Dave Mallough et Glen Boughton, de la Station de recherches de Regina. Plusieurs souches indifférentes à la longueur du jour (photopériodiques) et possédant des caractères agronomiques

M. Burrows est chef de la Section des cultures céréalières, à la Station fédérale de recherches d'Ottawa.

CDA's Research Branch Director-General Dr. B. B. Migicovsky (right) and Cereal Crops Section Head Dr. V. D. Burrows view daylight insensitive oat strains from Ottawa, growing in the USDA Winter Oats Nursery at Brawley, Calif. Following this extra growing season, oat seeds are returned to Canada for test growth in a wide range of latitudes and climatic conditions.

M. B. B. Migicovsky (à droite) Directeur général de la Direction de la recherche d'Agriculture-Canada et le chef de la section des céréales, M. V. D. Burrows, examinent les variétés d'avoine photopériodiques d'Ottawa. Celles-ci croissent à la pépinière d'hiver pour les avoines du ministère de l'Agriculture des États-Unis à Brawley en Californie. Après cette saison spéciale, les semences sont ramenées au Canada où elles subissent des essais dans un éventail très large de conditions climatiques et de latitudes.

BLENDED GENES

The genes governing daylength insensitivity were derived from another species of oat *Avena byzantina* (C.W.544) which was collected in Bodrum, Turkey by the Canada-Wales Oat Collecting Expedition in 1964. These genes have been blended with many of the agronomically desirable ones of *Avena sativa.* The resultant plants are not as sensitive as normal oat varieties to changes in photoperiod exposure and they flower normally under shorter photoperiods. The term insensitive, however, is not really an accurate description of their flowering response; a better term might be "less sensitive". In northern latitudes the insensitive strains flower too early to permit high yield potentials. This has been overcome by selection for lateness which is probably conditioned by genes governing temperature response.

Oat varieties possessing insensitivity genes should be superior to sensitive varieties. They should be more adaptable over wider latitudes and should form better parental material for synthesizing varieties that can be sown late in the season in northern latitudes. Oats are commonly sown later in spring than

souhaitables et des caractères de précocité convenables seront disponibles pour des essais à grande échelle au Canada en 1973.

COMBINAISON DE GÈNES

Les gènes responsables de l'indifférence photopériodique proviennent d'une autre espèce d'avoine Avena byzantina (C.W.544), qui a été recueillie à Bodrum, en Turquie, par le groupe canado-gallois de prospection de l'avoine en 1964. Ces gènes ont été combinés avec de nombreux autres de l'*Avena sativa* possédant des caractères agronomiques souhaitables. Les plantes obtenues ne sont pas aussi sensibles que les variétés d'avoine ordinaires, aux variations photopériodiques et fleurissent normalement lorsqu'elles sont soumises à des durées d'éclairement plus courtes. Toutefois, le qualificatif "indifférent" ne décrit pas exactement leur réaction; un meilleur terme serait "moins sensible". Dans les régions septentrionales les lignées indifférentes ont tendance à fleurir trop tôt ce qui abaisse leur rendement potentiel. Cet inconvénient a été surmonté par la sélection en fonction de la tardivité, qui est probablement régie par les gènes commandant la réaction à la température.

Les variétés d'avoine possédant des gènes d'indifférence devraient être supérieures aux variétés sensibles. Elles devraient pouvoir s'adapter à diverses latitudes et constituer un meilleur matériel génétique pour la création de variété pouvant être semées tardivement dans les régions septentrionales. On sème généralement l'avoine plus tard, au printemps, que le blé ou l'orge qui ont une plus grande valeur commerciale.

Le rendement potentiel réel de l'avoine n'est probablement que rarement atteint. Cependant, un rôle important qui lui est attribué dans l'agriculture canadienne est de servir de "cultures d'urgence", destinées à compenser la perte d'une autre culture.

Un des grands avantages des variétés indifférentes pourrait être d'éliminer, ou du moins de minimiser la réduction de la taille des panicules et du nombre des grains, que l'on associe normalement à des semailles tardives. Une combinaison de l'indifférence photopériodique et de la résistance à l'induction florale cau-

wheat or barley because the latter are of higher cash value. The true potential of oats is probably seldom realized. However, and this is an important function for oats on the farm each year in Canada, "emergency plantings" are made to offset one disaster or another.

One of the advantages of insensitive varieties may be to overcome or minimize the reduction in head size and kernel number normally associated with delayed seeding. A combination of daylength insensitivity and a resistance to the flower-promoting effects of high temperature may provide the type of variety required for delayed seeding. It is now possible to look for this type of temperature response without it being masked by the flower-promoting effects of daylength sensitive genes.

EXPORTABLE RESULTS

One of the main advantages of breeding insensitive varieties is that research results become more exportable. Conversely, if other research organizations in other countries also breed insensitive varieties their results become more importable. For example, at present we are attempting to breed daylength insensitive varieties with high protein content. This is being attempted because oat protein has a good amino acid profile and because we possess genetic stocks of normal oats with high protein content. If successful, our producers of grain and livestock could benefit greatly because such a feed grain could reduce the amount of protein purchased for farm use. Similarly, people in countries situated at the lower latitudes may be able to grow our daylength insensitive varieties as an added source of protein in their diet.

In any research activity it is often the unexpected that may yield the "pay-off" for the whole project. In some of our genetic stocks we have isolated lines that segregate into "monster" and normal plants. These "monster" plants are truly remarkable for size and leafiness, but fail to flower normally in Ottawa. They initiate flowers successfully but further growth of the apex is abnormal. The "monsters" strongly resemble our standard oat varieties when grown in California (*i.e.* longday plants grown in short days). By using the California Winter Oat Nursery we have been able to produce enough seed of the "monster" oat strain for experimental purposes. We are now engaged in experiments designed to determine how to produce seed of the "monster" varieties in Canada. Such a variety would provide an excellent forage crop which would yield its maximum amount of forage at a time when our perennial hay is in a regenerative stage after the first cut and our corn is not ready for harvest.

It may turn out that this seed production problem is never solved, but the advantages of the whole insensitivity program will almost certainly be significant to oat improvement. Insensitivity genes have contributed greatly to the success of wheat and rice crops. It is hoped that they will do the same for oats.■

sée par les températures élevées pourrait constituer les deux caractères principaux d'une variété destinée à des semailles tardives. Il est désormais possible de rechercher ce type de réaction à la température sans qu'il soit masqué par les effets photo-inductifs des gènes de sensibilité à la longueur du jour.

RÉSULTATS EXPORTABLES

Un des grands avantages de la création de variétés indifférentes est que leurs produits deviennent de plus en plus exportables. Inversement, si d'autres organismes de recherches dans d'autres pays créent aussi des variétés insensibles, leurs produits deviendront plus avantageusement importables. Ainsi par exemple, nous essayons actuellement d'obtenir des variétés photopériodiques à forte teneur en protéine. La raison en est que la protéine de l'avoine présente une bonne composition en acides aminés et que nous possédons du matériel génétique d'avoine ordinaire à forte teneur en protéine. Si nous y parvenons, nos céréaliculteurs et nos éleveurs pourront en tirer d'énormes avantages car l'emploi d'une telle céréale fourragère permettrait de réduire les achats de protéines pour l'alimentation du bétail. De même, les agriculteurs des pays de climat plus chaud pourront cultiver nos variétés indifférentes à la longueur du jour comme source additionnelle de protéine dans leur régime alimentaire.

En recherche, ce sont souvent les résultats inattendus qui rentabilisent l'ensemble du projet. Dans notre matériel génétique, nous avons isolé des lignées qui en disjonction, en donnent des plantes normales et des plantes monstrueuses. Ces dernières sont vraiment remarquables par leur taille et l'abondance de leur feuillage mais ne peuvent fleurir normalement à Ottawa. Les premières phases de la floraison s'effectuent normalement, mais la croissance de l'apex est ensuite anormale. Elles ressemblent beaucoup à nos variétés normales d'avoine cultivées en Californie c'est-à-dire les plantes héméropériodiques cultivées en période de jours courts). Nous avons pu produire à la California Winter Oat Nursery une quantité suffisante de semence de la souche d'avoine monstrueuse pour nos fins d'expérimentation.

Nous effectuons actuellement des expériences sur les conditions de production de semence des variétés monstrueuses au Canada. De telles variétés constitueraient d'excellentes cultures fourragères dont l'époque de rendement maximal en fourrage se situerait au moment où nos plantes herbagères vivaces entrent en stade régénération après la première coupe et alors qu'il est encore trop tôt pour récolter notre maïs. Il se peut que ce problème de production de semence ne soit jamais résolu, mais les avantages du programme de sélection de l'avoine photopériodique seront très certainement significatifs. Les gènes régissant l'indifférence ont grandement contribué à l'amélioration du blé et du riz, et l'on espère qu'il en sera de même pour l'avoine. ■

COOPERATION IN DEVELOPING WHEAT VARIETIES

D. S. McBEAN

Grâce à un système coopératif établi avec les gouvernements mexicain et américain, et le Conseil de contrôle de la qualité des cultures des États-Unis, les sélectionneurs de blé de la Station de recherches d'Agriculture Canada de Swift Current, Saskatchewan, peuvent désormais échanger du matériel expérimental avec les améliorateurs de blé de toutes les parties du monde, et obtenir deux générations de blé par année.

Canadians do not normally think of Mexicans as toiling under the blazing sun to harvest wheat for the Canadian prairies. Yet this is exactly what a number of Mexicans are hired to do in the spring of each year; harvest, thresh, and ship Canadian wheat back to Canada for seeding in May.

The CDA Research Station at Swift Current, Sask., along with other institutions, takes advantage of this winter program in Mexico. The whole scheme is made possible through the co-operation of the Mexican Government and the U.S.A.'s Crop Quality Council. A typical Swift Current program involves the preparation of 2,000 selections of wheat—not only bread wheats but also utility and durum wheats. These are shipped to the Crop Quality Council at Minneapolis, U.S., in late September. Along with similar entries from other Canadian and American projects, the wheat varieties are hand-sown in late October on irrigated land at Obregon, Mexico. Five months later: plant breeders examine the crops grown, to determine which selections should be harvested and returned for further testing in Canada.

CALIFORNIA PROJECT

With excellent cooperation between the Canadian and American Departments of Agriculture, a similar scheme operates in the Imperial Valley of California. There, the growing season is extended by shorter days during the winter months; consequently, material from the Imperial Valley project arrives back in Canada during early May. Glen Boughton from the Research Station at Regina, Sask., working very closely with his American counterparts at Brawley, California, coordinates the harvesting and shipping

Mr. McBean is a cereal production specialist at CDA Research Station, Swift Current, Sask.

(Above) Threshing plots of Canadian wheat-breeding material in Mexico in March.

(Opposite page) Genetic stocks used in the Swift Current wheat breeding program, come from all parts of the world.

(Below) At Swift Current, advanced testing of potential new varieties of wheat is speeded up by having every other generation grown in a winter nursery in Mexico or California.

of Canadian material—often a 12-hour-a-day job—in order to meet spring seeding deadlines.

The questions may be asked: "Why is there a need for this type of expense and haste?" "Why not proceed at the same pace that saw the development of such splendid wheats as Marquis and Thatcher?"

Without going into details, the answers lie in the fact that world markets for wheat are now much more diverse. Problems are more numerous and complex, and international competition for both old and new markets is very keen. No longer is Canada concerned only with the bread-wheat market in the United Kingdom. We must also consider markets in Russia, China, Southeast Asia and Africa; in addition, we must develop utility wheats and meet the specific requirements demanded by importers of durum wheat.

Development, production, and stockpiling of various classes of wheat are not easily obtained. Plant breeders normally require at least 10 generations of testing and selecting in order to develop a new variety. This means that they must have very clear objectives, not only for agronomic and yield characteristics but for quality standards as well. There is obviously no particular value in producing a fine crop of wheat if the grain does not fit the requirements of the buyer.

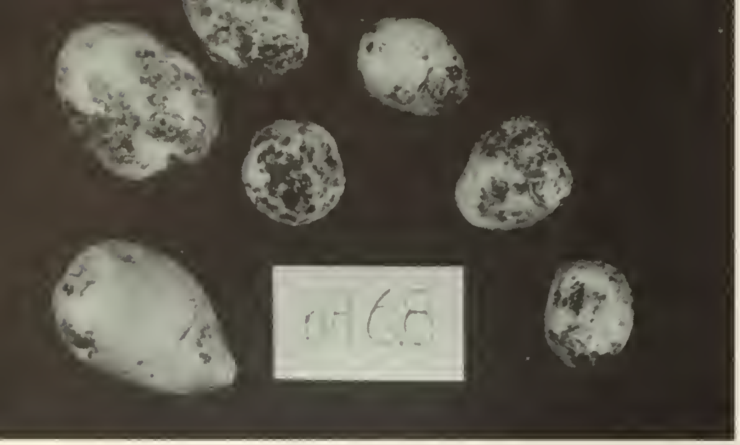
MARKETING FUNCTION

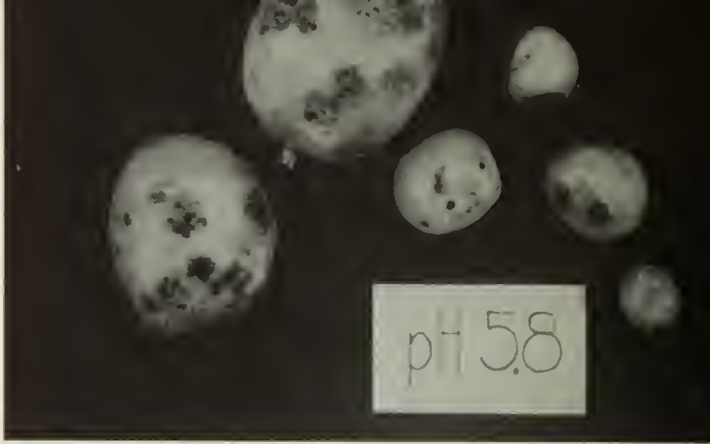
This is where the marketing people fit into the over-all picture. Theirs is an important function—to determine what is required by the buyer and to advise the plant breeders of such requirements.

Any technique that shortens the period between the stated objective and the release of a wheat variety for commercial production is of primary concern to a host of people in many countries. This common concern has resulted in a fine system of cooperation between many disciplines both national and international in scope.

Taking advantage of these systems, the wheat breeders at Swift Current are able: to exchange material with wheat breeders in all parts of the world; to handle large populations because of the availability of machines and computers; to grow two generations a year by making use of the Mexican and Californian programs. They are aided immensely in their selection program by the plant pathologists who screen the material for resistance to root rot, leaf and stem rust; by the cereal chemists who provide the all-important quality data, and by the plant physiologists who study the development of the plants under a wide range of growing conditions.

It has been recognized for some time that the day of individual effort is past. It is also recognized that the coordination of multiple efforts introduces new problems. The present system is far from perfect, but it is constantly improving as many people willingly exchange ideas and share their material and efforts.■





SOIL ACIDITY AND POTATO PRODUCTION

C. R. LEE

Des recherches effectuées à la Station de recherches d'Agriculture Canada de Fredericton, Nouveau-Brunswick, montrent que certaines variétés de pomme de terre sont sensibles à la teneur en aluminium et en manganèse du sol de culture. On peut obtenir des rendements accrus en tubercules de poids spécifique plus élevé en podzol fortement acide en ajoutant des quantités suffisantes de magnésium, de calcium et de phosphore au sol.

(Above and to left) Suppression of common scab of potato tubers is achieved with low soil pH.

In many parts of eastern North America, potatoes are grown on highly fertilized, strongly acid soils. Soil pH has purposely been maintained at 5.4 or below in order to suppress common scab of potatoes. While scab may be suppressed by low soil pH, crops such as barley and oats in rotation with potatoes have grown poorly on many soils in the province of New Brunswick. High fertilization plus soil pH values below 5.0 can create a growth medium in which the concentrations of soluble Al and Mn are high enough to be detrimental to plant growth. For many years potatoes have been regarded as tolerant to acid soil conditions. Research conducted at the CDA Research Station, Fredericton, N.B., has shown that certain potato varieties are more sensitive to the concentration of Al and/or Mn in the growth medium than other varieties, and that an increase in yield and specific gravity of potato tubers can be obtained in strongly acid podzols by the addition of sufficient Mg, Ca and P to the soil.

HYDROPONIC EXPERIMENTS

Aluminum—In hydroponic nutrient solution and sand media experiments a differential tolerance to Al was found among potato varieties. Growth of Sebago potato plants was not affected by up to five parts per million (ppm) of Al. However, Katahdin and Green Mountain potato plants were adversely affected by 5 ppm of Al. Vegetative growth of Netted Gem potato plants was stimulated when exposed for 14 days to 1-5 ppm of Al in the medium. Potato plants grown in

Dr. Lee specializes in soil fertility and plant nutrition at the CDA Research Station, Fredericton, N.B.

Al solutions contained less Ca and Mg. Most of the plant P was accumulated in the roots with little of the element being translocated to plant tops. The differential Al tolerance among potato varieties appears to be related to the ability of the potato plant to absorb and utilize Mg and K. Plant absorption of Mg and K was higher in Al tolerant potato varieties.

When Netted Gem and Sebago potato plants were grown to maturity (120 days) in hydroponic sand media, plant growth was reduced as the concentration of Al increased. The addition of Al decreased the number and yield but increased the size and specific gravity of Netted Gem tubers. There were less knobby tubers when Al was added to the sand medium.

Manganese—The growth of Netted Gem potato plants was sensitive to the concentration of Mn in the hydroponic medium. Visual symptoms of Mn-induced Fe deficiency were observed in the upper leaves of plants growing in Mn solutions after 14 days exposure. However, when Netted Gem potato plants were grown to maturity there were no adverse effects of Mn on the dry matter production of plant tops even though plant stems and petioles exhibited typical Mn toxicity symptoms. Tuber yield was depressed only after an excessive amount of Mn (40 ppm) had been added to the sand. Manganese did not influence the number, size or specific gravity of potato tubers.

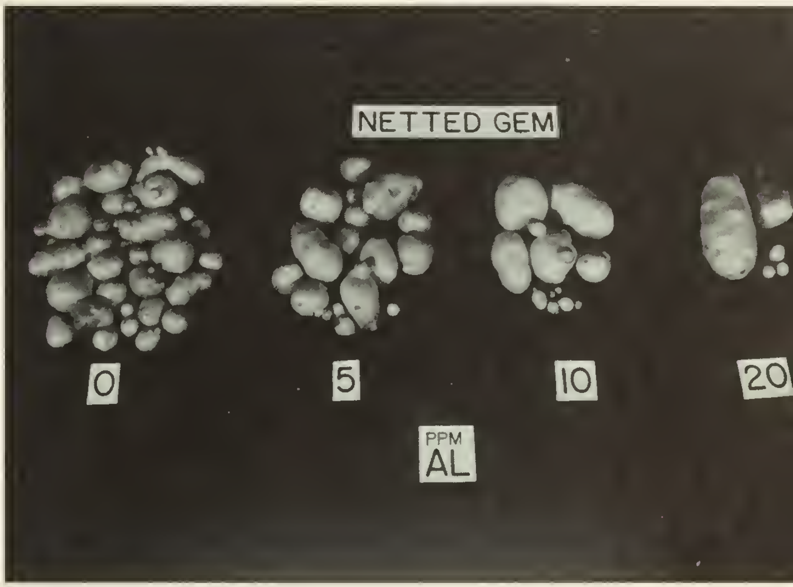
Aluminum-Manganese Interactions—The growth of Netted Gem potato plants was found to be influenced by counteracting effects of Al and Mn present in hydroponic nutrient solution and sand media. Visual symptoms of Mn-induced Fe deficiency could be eliminated by adding Al to the medium. Aluminum counteracted this toxic effect of Mn by increasing the uptake of Fe which subsequently lowered Mn/Fe concentration ratios in potato tops. Whenever the Mn/Fe concentration ratios were reduced to 18 or below, Mn-induced Fe deficiency symptoms were not observed.

A counteracting effect was also observed in the size of potato tops. Aluminum stunted plant tops, while Mn lengthened them. The effect of Al and Mn on potato-top size may explain why fields of abnormally small potato tops are very seldom observed in the acid soils of Eastern Canada.

Aluminum counteracted the toxic effects of Mn on tuber yield of Netted Gem potatoes. With no Al, excessive Mn (40 ppm) depressed tuber yield. However, with Al, Mn concentrations did not affect tuber yield. When excessive Al (20 ppm) was added to the sand, Mn actually increased tuber yield.

With the knowledge obtained from hydroponic experiments, it was obvious that in order to get an accurate evaluation of the effects of soil acidity on potato production, the influences of both Al and Mn concentrations present in podzols would have to be considered.

(Above and below) The size of potato tops, and the number and yield of potato tubers are reduced by the presence of Al in hydroponic sand media.



GREENHOUSE SOIL EXPERIMENTS

To evaluate the best management practices for potato production in acid podzol soils, an acid Caribou soil was obtained for further greenhouse experiments. The growth of barley on this soil the previous year was very poor. Soil treatments, based on the information from the hydroponic experiments, were selected in an attempt to improve the fertility of this soil.

Preliminary greenhouse soil experiments showed that an acid Caribou soil need only be limed from pH 4.6 up to pH 5.2 to improve plant growth and tuber yield. Raising soil pH with limestone reduces the amount of extractable Al and Mn in the soil, reduces the amount of Mn in plant tops which decreases the amount of black specks observed on plant stems and petioles. Liming the soil to pH 5.8 was of no further benefit, but could increase potato scab incidence. In further experiments, raising soil pH from 4.6 to 4.9

Manganese toxicity symptoms (black specks on potato stems and petioles), increase as the soil pH is decreased. From left to right: pH 5.8, 5.5, 5.2, 4.9 and 4.6.

and 5.2 improved plant top growth and increased the yield and quality of potato tubers. Liming this acid Caribou soil to pH 4.9 was as good as pH 5.2z Since Al tolerance among potato varieties appears to be related to Mg absorption, an application of 1 ton/A $MgSO_4$ (epsom salt) was evaluated and found to improve plant top growth and increase tuber yield by 20 percent. The amount of Mg in 1 ton/A of $MgSO_4$ was equal to the amount of Mg applied when the soil was limed to pH 5.2 with dolomitic limestone. Since acid podzols are relatively low in available Ca and P, an application of 1 ton/A of superphosphate was evaluated and found to improve plant top growth and tuber yield. When the $MgSO_4$ and the superphosphate treatments were applied together at a soil pH of 4.6, the resulting 40 percent increase in tuber yield was equal to the tuber yield obtained when the soil was limed to either pH 4.9 or 5.2. Tuber quality was also improved with either the application of Mg + P or limestone. The highest yield of high quality tubers was obtained when 1 ton/A of superphosphate was applied and the soil was limed to pH 4.9. These results emphasize the importance of maintaining high levels of Mg, Ca and P in acid podzols for adequate production of potatoes. A good yield of quality potato tubers can be obtained on very strongly acid soils provided sufficient Mg, Ca and P are present in the soil.

Another treatment evaluated was 25 tons/A of cow manure. While the application of cow manure at a soil pH of 4.6 resulted in excessive Mn in plant tissues with severe Mn toxicity symptoms on potato stems and petioles, tuber yields were increased by 28 percent over the control plants. However, tuber quality remained low.

There was no indication of an increase in scabby tubers in any of the selected soil treatments.

In summarizing management practices that seem promising for potato production on strongly acid podzols in Eastern Canada, two avenues appear to exist:

1. For potato growers who want to lime their soil, liming to pH 4.9 will increase both tuber yield and quality. An additional soil application of either 1 ton/A of superphosphate or 25 tons/A of cow manure will further increase tuber yield. However, a lower tuber quality may result with cow manure.
2. For potato growers who do not wish to lime their soils for fear of scab, increasing soil levels of Mg, Ca and P by one application of 1 ton/A of $MgSO_4$ plus 1 ton/A of superphosphate will increase both the tuber yield and tuber quality. While 25 tons/A of cow manure will produce a similar yield of tubers as above, the quality of the tubers may be lower.

Further research will be conducted to evaluate these management practices under field conditions on various soil types with different potato varieties. Lower rates, frequency of application and cheaper sources of Mg and calcium phosphate will be evaluated. The influence of these management practices on the development of potato scab will also be studied. ■

INFLUENCE OF SELECTED SOIL TREATMENTS ON SOIL pH; SOIL EXTRACTABLE Al AND Mn, POTATO TISSUE Al, Mn AND Mn/Fe CONTENTS, POTATO TUBER YIELD AND SPECIFIC GRAVITY

Soil treatment	Soil pH	Soil extractable		Leaf content			Tuber yield	Specific gravity
		Al	Mn	Al	Mn	Mn/Fe		
		ppm	ppm	ppm	ppm		g	
Check	4.6	84	3.2	157	1764	10.1	115	1.062
Mg[a]	4.6	84	3.2	206	1570	4.7	138	1.063
P[b]	4.6	77	3.5	123	1147	7.3	147	1.065
Mg+P	4.6	72	2.4	130	1085	4.8	162	1.070
L_1[c]	4.9	50	1.4	99	482	3.0	168	1.071
L_2[d]	5.2	26	0.6	100	320	2.2	170	1.072
L_1P	4.9	45	1.1	116	414	2.3	192	1.073
O[e]	4.6	77	4.4	135	2879*	19.2	147	1.064

[a]1 ton/A $MgSO_4$.
[b]1 ton/A superphosphate.
[c]½ ton/A dolomitic limestone.
[d]1 ton/A dolomitic lime.
[e]25 tons/A cow manure.

*Severe Mn toxicity symptoms were observed on plant stems and petioles.

FORAGES FOR PEACE RIVER ACID SOILS

Alfalfa is very sensitive to acid soils and does poorly (0.45 tons hay per acre at left), unless the soil is limed (1.75 tons of hay per acre, right).

C. R. ELLIOTT and P. B. HOYT

Environ un demi-million d'acres de sol acide sont en culture dans la région de la Rivière de la Paix s'étendant en Alberta et en Colombie-Britannique. La Station de recherche du ministère fédéral de l'Agriculture à Beaverlodge (Alberta) tente de déterminer les caractéristiques particulières de certains sols acides; ainsi, en matière de culture, elle pourra faire des recommandations plus précises que celles qui sont possibles actuellement.

There are approximately 0.5 million acres of strongly to very strongly acid soils under cultivation in the Peace River region of Alberta and British Columbia. Successful cropping of such soils can be achieved either by liming or by the use of species that are relatively tolerant to soil acidity. Farmers in the region have made little use of lime because it is expensive and not readily available. Consequently, the use of acidity-tolerant species is especially important.

In recent studies at Beaverlodge the relative tolerance of timothy, red fescue, bromegrass, Kentucky bluegrass, Russian wild ryegrass, alsike clover, red clover, alfalfa and birdsfoot trefoil to soil acidity was determined under field conditions by measuring forage and seed yields on three limed and nonlimed very strongly to strongly acid soils (pH 4.1 to 5.1).

Prior to seeding the forages, lime (calcium hydroxide) was mixed into the top 6 inches of soil at a rate estimated to bring soil to pH 6.5. Three years later the analysis of the limed top soil showed the pH was still in the 5.6 to 6.1 range. Soil pH below the 6-inch depth had not changed indicating that there was little downward movement of lime.

Dr. Elliott is a grass seed production specialist, and Dr. Hoyt is head of the soils section, CDA Research Station, Beaverlodge, Alta.

TOXIC CONCENTRATIONS

Nonlimed topsoils also differed in content of plant-available aluminum and manganese. Aluminum content ranged from 42 to 385 ppm, while manganese was 7 to 48 ppm. At such high concentrations these elements proved toxic to many field crops. Liming acid soils not only raised the pH but reduced the plant-available aluminum from 385 to 5 ppm and the manganese from 48 to 7 ppm.

Crop species have been ranked over the years by other researchers as to the minimum soil pH they can tolerate but in our experiments species varied considerably from site to site. Such behaviour is to be expected since different species vary in their sensitivity to aluminum and manganese toxicity. Alsike clover has been ranked as more acid tolerant than red clover when grown for hay. Our studies agreed but only for acid soils high in manganese and low in aluminum.

FORAGE FOR PEACE RIVER ACID SOILS

Where the aluminum content was high, red clover was more tolerant. As a seed crop red clover produced superior yields and demonstrated a high tolerance to both aluminum and manganese.

Similarly, red fescue is more acid tolerant than timothy under conditions of high exchangeable aluminum. Both species showed some manganese tolerance and red fescue was unique in not responding to liming at any location, whether grown for seed or herbage.

Bromegrass, Kentucky bluegrass and birdsfoot trefoil displayed only moderate resistance to acid soil conditions while Russian wild ryegrass and alfalfa did very poorly unless the soils were limed.

Our research is continuing to define tolerance levels of forage species to aluminum and to manganese and to determine the specific characteristics of particular acid soils so that crop recommendations may be more precise. ■

The author examines weevil damage in alfalfa field.

ALFALFA WEEVIL
BLESSING IN DISGUISE?

C. D. F. MILLER

L'auteur établit la fiche signalétique du charançon postiche de la luzerne et en décrit l'importance en Amérique du Nord. Il traite ensuite du cycle évolutif et du développement de cet insecte au Canada, et de l'importance de bonnes techniques culturales dans la lutte contre cet insecte.

The alfalfa weevil, technically known as *Hypera postica* (Gyllenhal), is an important pest of alfalfa. It was introduced accidentally by man, from Europe to North America, where it was first detected in Utah, U.S.A., in 1904. It has gradually spread since then, to nearly all of the alfalfa growing regions on this continent. It is purportedly costing U.S. alfalfa producers $50 million annually. Is this insect pest costing Canadian producers of alfalfa a similar loss? This author believes that such is not so, if the Canadian alfalfa producer properly manages his crop.

Our research, conducted at the CDA Research Station, Harrow, Ont., shows that the alfalfa weevil can be virtually eliminated in pure stands of alfalfa in Canada by following recommended cropping practices every year.

ANNUAL DEVELOPMENT

Our research, and literature on the subject, indicate that the alfalfa weevil completes only a single generation each year in Canada. The adults leave their hibernation sites between late March and mid-April. They start laying eggs from late April to mid-May, depending on yearly conditions. The peak density period for the egg stage occurs during June; for the larval stage, between mid-to-late June and mid-July, and for the pupae, between early and mid-July. The peak density periods for the various stages occur slightly earlier in southwestern than in southeastern Ontario.

Adults that left hibernation in the spring and remained alive at midsummer became inactive, especially during extremely warm periods. They lay few eggs during July, August and/or early September. Larvae that hatch from these eggs are economically insignificant.

CONTROL OF ALFALFA WEEVIL

Research to date in Canada strongly suggests that the damaging stages of the alfalfa weevil reach peak density when alfalfa is in its first flowering phase. Weevil densities reach the damaging stage slightly earlier in the extreme southwestern portion of Ontario.

Canadian crop specialists generally agree that, in

Dr. Miller is head of the entomology section, CDA Research Station, Harrow, Ont.

order to obtain the greatest amount of total digestive nutrients from alfalfa as forage, the crop should be cut when it has reached the first flowering phase in most parts of Canada.

Alfalfa producers who cut their alfalfa as recommended by Canadian crop specialists have little or no problem with the alfalfa weevil. These producers harvest their alfalfa before it is decimated by developing weevil larvae. Cutting alfalfa at the first flowering stage reduces the season's alfalfa weevil population below an economic threshold. In general, this precludes a need for other control measures.

It is appropriate to suggest that the alfalfa weevil, an important pest of alfalfa, has forced serious Canadian alfalfa-producers into a position of proper management practices. For this reason, the weevil may truly be a blessing in disguise. ■

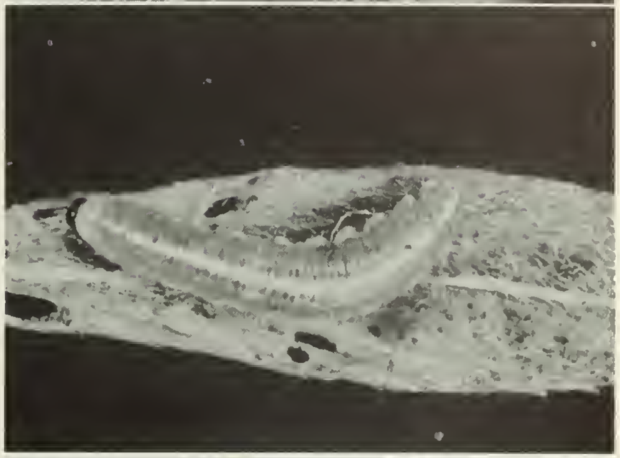
LIFE HISTORY OF THE ALFALFA WEEVIL

The alfalfa weevil survives the winter in Canada only as an adult. Adults that survive the rigors of the Canadian winter leave hibernation sites in the spring and mate. The females chew holes in the stems of the alfalfa plants and usually deposit 30 or so small, oval yellow eggs, in each hole. The female generally plugs the hole with plant tissue macerated with her mandibles. The eggs turn a yellowish-brown as they mature and just before hatching the larval head capsule becomes visible through the chorion. Incubation of the eggs takes eight to twelve days, and the developing weevils pass through four stages before becoming adults.

The tiny, first-instar larvae crawl to the tops of the alfalfa plants and feed voraciously on the unopened florets where they are often hidden. The older larvae feed on buds and leaves, but the final, fourth-instar larvae, feed mainly on the leaves between the veins giving them a skeletonized appearance. These, the largest larvae, pupate in cocoons which they construct among the upper portions of the alfalfa plants. The period from egg-hatch to pupation takes 10 to 14 days. The pupal period lasts from six to ten days.

The newly formed adults chew their way out of the cocoons and feed for about three weeks on the margins of the alfalfa leaves, giving them a tattered appearance. The weevils also feed on the stem epidermis. These adults then begin a quiescent period known as aestivation. They resume activity in the late fall when they do some feeding, some mating and lay a few eggs before cold weather forces them into hibernation. Eggs layed at this time of the year do not survive the Canadian winter.

The following spring the cycle begins again.



(Top) Alfalfa weevil eggs.
(Top center) Alfalfa weevil fourth-instar larva.
(Lower center) Effect of alfalfa weevil larval feeding on alfalfa leaves.
(Bottom) Alfalfa weevil cocoon.

ECHOES
FROM THE FIELD AND LAB

One often hears people complaining: "It's not the heat, it's the humidity". A difference in humidity largely accounts for two systems of forage handling at CDA Research Station, Melfort, Sask., (left), and CDA Experimental Farm, Kapuskasing, Ont. (right). Both stations are subject to extreme temperatures, but because of more humid conditions at Kapuskasing research is being directed toward formic acid treated wet silage, compared to a hay drying tower at Melfort.

MOSQUITO WARFARE Few people suffer mosquitoes gladly. Fewer know how to deter the hungry winged hordes that haunt the outdoors on otherwise beautiful spring and summer days.

A new CDA publication offers extensive information and control advice for *Planning an Anti-Mosquito Campaign*. A compact, 15-page brochure, *PAA-MC* explains:

- Why control campaigns are necessary. (Because Canada's extensive breeding grounds produce nearly 60 different kinds of mosquitoes; most must feed on blood in order to lay eggs, thus causing considerable discomfort to people and animals).
- The mosquito life cycle.
- The need for planning a full-fledged anti-mosquito campaign before warfare commences in the spring.
- How to conduct a mosquito survey and recruit the efforts of several communities (mosquitoes pay no heed to fences or municipal boundaries).
- The equipment necessary and available to fight mosquitoes.
- The need to consult representatives of provincial departments of health or agriculture, to learn what insecticides are permitted in each area.

In addition to the booklet *Planning an Anti-Mosquito Campaign* (publication 1485), further information about the control of mosquitoes is available from: The Information Division, Canada Department of Agriculture, Sir John Carling Building, Ottawa, Ont., K1A 0C7.

LUTTE CONTRE LES MOUSTIQUES Peu de gens subissent allègrement la présence des moustiques. Encore moins nombreux sont ceux qui savent se débarrasser de ces hordes affamées qui, du printemps à l'été, enlèvent tout leur charme aux activités de plein air.

Une nouvelle publication du ministère de l'Agriculture du Canada, *Campagne anti-moustiques – Organisation* donne de nombreux renseignements et conseils. En 17 pages elle explique:

- pourquoi il est nécessaire d'organiser des campagnes (les nombreux foyers de reproduction du Canada produisent près de 60 espèces différentes qui doivent pour la plupart se nourrir de sang pour pondre leurs oeufs. Ils constituent un désagrément considérable pour l'homme et les animaux.)
- le cycle évolutif des moustiques.
- la nécessité de planifier une campagne globale de lutte contre les moustiques avant de leur déclarer la guerre, au printemps.
- comment faire le relevé des foyers de reproduction et conjuguer les efforts de plusieurs municipalités (les moustiques ne reconnaissent ni clôtures ni limites municipales)
- le matériel nécessaire
- la nécessité de consulter les fonctionnaires des ministères provinciaux de la Santé ou de l'Agriculture pour savoir quels sont les insecticides autorisés dans la région concernée.

En plus de cette brochure (publication n° 1485), on peut obtenir de la Division de l'information du ministère de l'Agriculture du Canada, édifice Sir John Carling, Ottawa, K1A 0C7, d'autres renseignements sur la lutte contre les moustiques.

PESTICIDES REVIEW As a major user of pesticides, agriculture should be responsible for research, information, and regulations to protect the environment, comments the Canada Committee on Agricultural Meteorology.

Accepting the responsibility, the Committee invited experts to assist in reviewing current scientific knowledge about airborne pesticides. Of interest to the CCAM were the relation of pesticides to: their potential sources; spray dissemination; microscale, mesoscale and synoptic-scale transport; analytic techniques; biological significance; monitoring by a national network.

Although not exhaustive, the review resulted in the delineation of certain areas on

which to focus attention. These include: a need for comprehensive data on regions of pesticide pollution; a need for standard procedures for evaluating spray equipment and analyzing pesticides; a need for knowledge about the various fluxes by which pesticides leave and enter the wind field.

A series of position papers that provided background information for the review, have been published and are available from: Agrometeorology Section, Plant Research Institute, Canada Department of Agriculture, Ottawa, Ont., K1A 0C6.

CATTLE BROWSE If cattle are browsing decidious trees or shrubs extensively, they are probably receiving reasonably good nutrition, but extensive browsing may indicate that the grass is inadequate either in quality or quantity, says Dr. J. E. Miltimore, director, CDA Research Station, Kamloops, B.C.

A cooperative survey of cattle browse was undertaken by the Kamloops Research Station and British Columbia's Department of Agriculture. Simulating the browsing action of cattle, researchers took grass samples directly from the field, just before haying in the Cariboo-Chilcotin area. They also picked samples of willow, arctic birch, aspen, white birch, and the needles of coniferous trees such as pine and Douglas fir.

Results of the sampling survey showed that browse from deciduous trees was often richer in protein and phosphorus than the grass. Though some leaves were not as highly nutritious, calcium levels were found to be relatively high, with magnesium and copper twice as high in the leaves as the usual levels found in grass. Manganese and molybdenum were not greatly different from the grass, but zinc was almost 10 times as high in the leaves as in the grass. On the other hand, coniferous samples were appreciably lower in all nutrients, than decidious species.

MANURE FLAVOR ELIMINATED Foods grown on soils treated with chemical fertilizer have been denounced by some people as harmful, non-nutritious and tasteless. Organically grown food is claimed to be superior because of the assumption that plants assimilate organic nutrients from manures. This is far from the truth Dr. M. K. John, CDA Research Station, Agassiz, B.C., declares. None of the food plants can utilize organic nutrients. Compost or manure has to be decayed and converted to inorganic nutrients, similar in composition to fertilizer forms, before the nutrients can be absorbed by plants. Plants use about 15 elements altogether, all in the inorganic form. Plants, grown on sand culture or water culture to which only chemical nutrients have been added, are found to be similar in chemical composition, taste and food value to those grown in soil where barnyard manure is added.

Where nitrogen fertilizer has been accused of being a factor in nitrate poisoning, Dr. John points out that this has happened when leafy vegetables have been grown under very high fertility and the produce canned under certain conditions. The effect would have been the same had organic manure been used in high amounts.

WHAT'S IN A NAME? People and objects are likely to be called a lot of things in their day. For example, baked potatoes have their share of synonyms. In Canada, Netted Gem is recognized as a standard name for a baking potato. In a CDA publication entitled Selecting, Exhibiting and Judging Potatoes, the author, E. H. Peters, points out that Netted Gem is also known as Russet Burbank, California Russet, Idaho Russet, Golden Russet. "Idaho Baker" has even been trademarked by the State of Idaho. Whatever the name, it's usually the same when it comes from the oven, big and beautiful, and tasting so good. Mr. Peters, who recently retired from the CDA Plant Protection Division, goes on to explain that a Netted Gem for "show" should be about eight ounces in weight, and 4½ x 2¾ x 2¼ inches in size. The "eyebrows" of a Netted Gem, Peters informs his readers, should be short, inconspicious and curved. This information and more will be found in Publication 1421, available from the Information Division, Canada Department of Agriculture, Ottawa, K1A 0C7.

CDA Officers are sometimes required to smoke on the job. Here George Laporte, L'Assomption Experimental Farm, lights up a cigar "to sample the aroma" in the interest of science. Tobacco varieties with potential for cigars are bred and tested at the station. Quebec grown leaves are rolled into cigars by local manufacturers and given the final test by a panel, of which Laporte is an active member. The glass of water is part of the expertise of comparing one cigar with another.

TRENDS IN PRICES PAID AND QUANTITIES BOUGHT OF GOODS AND SERVICES IN FARMING

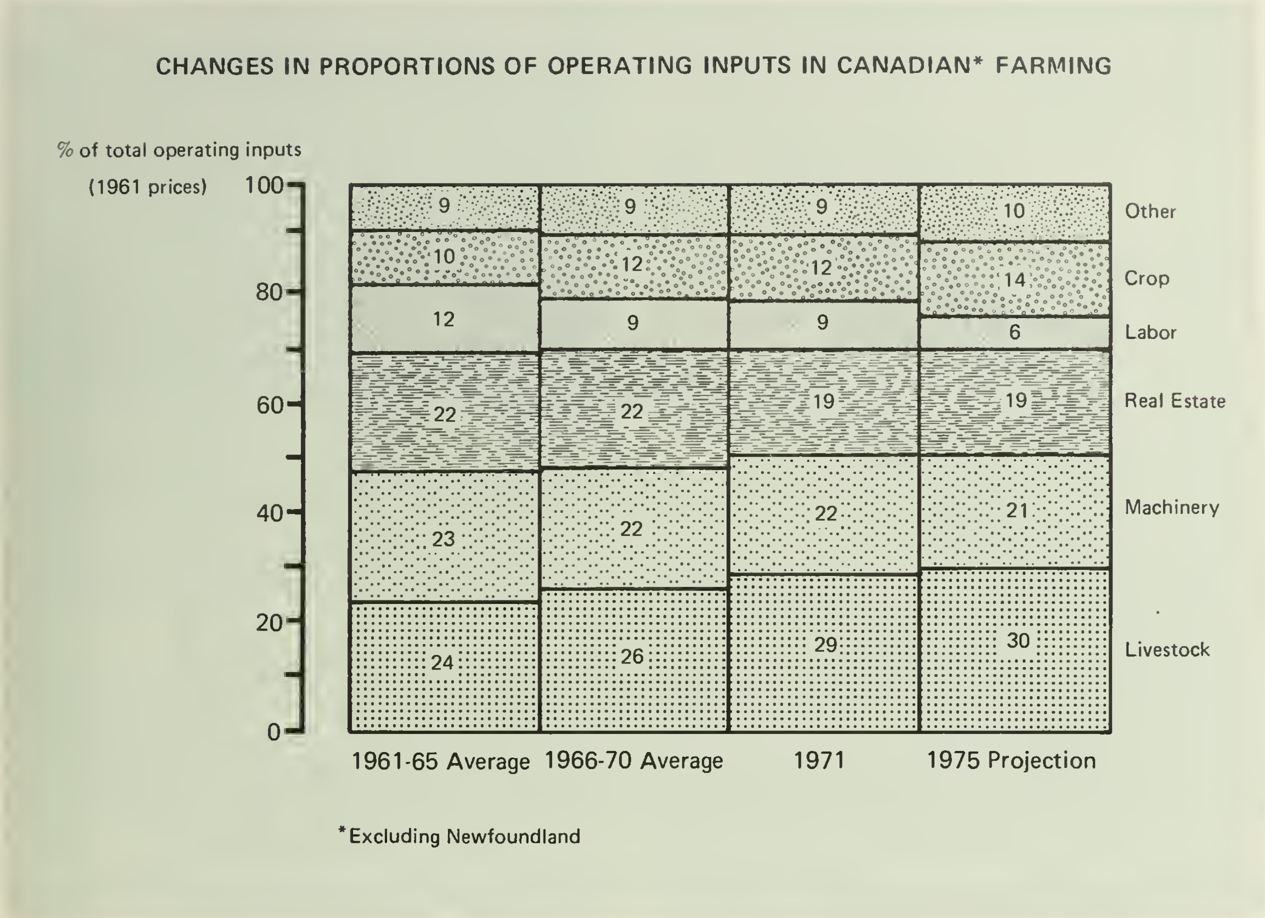
Then . . . and now in Western Canada: Forty-five horses and 12 men spent more time and covered less acreage in pre-mechanized days than do two men and two tractors today.

I. F. FURNISS

Au cours des années 1960, les prix des facteurs de production agricoles ont augmenté d'environ 3% l'an, tout comme la totalité des facteurs de production. Toutefois, les facteurs de production dont les prix ont augmenté à un rythme supérieur à la moyenne ont connu des accroissements généralement inférieur à la moyenne ont connu des accroissement généralement inférieur à la moyenne ou même des baisses. De plus, les agriculteurs ont acheté des quantités plus grandes des facteurs de production dont les prix augmentaient à un rythme inférieur à la moyenne. Ces tendances semblent indiquer qu'un facteur important de hausse de productivité agricole au cours des années 1960 a été le remplacement par les agriculteurs des facteurs de production les plus chers par d'autres relativement moins chers.

The purpose of this article is to examine the effects that the overall price increase of three percent a year in prices of farm inputs (goods and services bought), observed during the 1960's, had on total farm operating expenses, and to examine the "mix" of goods and services bought by farmers during the same years. Although the rate of increase in prices of all farm inputs, as measured by the Farm Input Price Index (1961 = 100), was around three percent a year, prices of specific inputs behaved differently. Thus, one would expect to find that farmers, as resource managers, substituted the less expensive factors of production (in terms of relative price increases), for the more expensive factors. However, at the same time, it is necessary to recognize that changing relative prices for factors of production are not the only reasons for changes in the resource mix. Other factors affecting the resource mix would include things such as changes in farm output in response to changes in demand, for example, increased beef production, and changes in industrial technology which can result in more efficient inputs available to agriculture at unchanged current prices. Also, there are technical limits to substitutions of inputs. For example, machinery, depending on its age and condition, will require repairs and fuel in a fixed relation.

Mr. Furniss is an economist, Research Division, Economics Branch, CDA, Ottawa.



regardless almost of the prices of these factors, if the machinery is to be used.

The table shows the rates of change in prices paid by farmers for specific groups of inputs and of the quantities bought during the 1960's. Prices of goods and services bought by farmers increased by more than the average rate of three percent a year for such factors as property taxes, wages of hired farm labor, mortgage credit, machinery expenses and building repairs. With the exceptions of interest charges on indebtedness and machinery expenses, the increase during the 1960's in the consumption of these factors of production was either less than one percent a year or a decrease occurred. Conversely, for some of those factors of production whose prices did not increase, important increases in purchases occurred. This was particularly so for fertilizers, consumption of which increased by nine percent a year with a slight downward trend in prices over the period. A somewhat similar trend was evident also for items associated with livestock production. Prepared feed prices rose by about one percent a year but the amount of feeds purchased by farmers from non-farm sources rose by more than five percent a year.

Thus, while farmers' total operating costs increased by six percent a year in current dollars from 1961 to 1970 (not shown in the table), 50 percent of that increase was due to increased prices of inputs and the balance was due to increased quantities purchased. However, for some of those inputs having the larger price increases, there was much less of an increase, if any, in the quantities bought. In the case of hired labor, the amount of labor hired declined.

The effects which relative changes in prices of inputs, but not, of course, in isolation, have on the total farm operating mix are illustrated in the accompanying figure. This chart shows very clearly that expenses associated with livestock and crop production, other than labor and machinery, are increasing proportions of total operating costs in real terms, that is, in 1961 constant dollars, while costs for machinery, real estate and labor are declining as proportions of total costs. Hired labor especially has declined from 12 percent of operating costs in the five-year period 1961-65 to nine percent in 1971. Continuation of this short-run trend will result in hired labor costs becoming six percent of total operating expenses by 1975.

CHANGES IN PRICES PAID BY CANADIAN FARMERS FOR GOODS AND SERVICES (INPUTS), AND IN QUANTITIES BOUGHT, 1961 TO 1970 AND 1970 TO 1971

Input prices/operating inputs (total expenses valued at 1961 prices)	Prices paid for inputs		Quantities of inputs bought	
	1961-70	1970-71	1961-70	1970-71
	annual rate of change (percent)			
Property taxes/taxes on owned land & buildings	4.7	0.5	0.2	−0.0
Farm rent/gross farm rent	2.6	0.8	0.3	5.8
Hired farm labor/wages to farm labor	7.0	4.9	−2.4	0.2
Mortgage credit/interest on indebtedness	8.9	7.7	4.4	−4.3
Petroleum products/petroleum, diesel oil & lubricants	1.5	3.3	1.8	0.5
Machinery & motor vehicle repairs, tires and batteries/machinery repairs	3.3	3.3	2.1	10.4
Motor vehicle licences and insurance/other machinery expenses[a]	4.6	7.5	3.8	−1.4
Fertilizer/fertilizer and lime	−0.1	3.3	9.0	19.0
Seed/other crop expenses[b]	1.4	−0.6	2.7	1.8
Prepared feed/feed[c]	1.1	1.3	5.3	4.7
Artificial insemination/other livestock expenses[d]	1.0	3.9	4.8	2.3
Building repairs/repairs to buildings	4.7	4.8	−0.1	−2.2
Electricity/Electricity and telephone	1.0	3.6	3.8	−1.8
Small tools and supplies/miscellaneous[e]	1.6	3.2	4.3	−0.5
Total inputs[f]/total operating expenses (inputs)[g]	3.1	3.1	3.0	3.1

[a]Includes tires and antifreeze.
[b]Includes pesticides, irrigation, containers and twine.
[c]Purchased from non-farm sources.
[d]Includes purchases of feeder livestock, registration fees and veterinary expenses.
[e]Includes fencing, custom work, insurance and other expenses.
[f]Includes prices of capital goods.
[g]Excludes depreciation allowances.

Sources: (1) *Farm Input Price Indexes*, Statistics Canada, Cat. No. 62-004 Quarterly.
(2) *Farm Net Income*, Statistics Canada, Cat. No. 21-202 Annual.

NOTE: The item description before the slash mark (/) is as used in Ref. (1) while that following is as used in Ref. (2).

SUMMARY AND CONCLUSIONS

During the 1960's, farm input prices rose by about three percent a year as did the total quantity of inputs purchased. However, some input prices rose by more than the average rate. Generally, the quantities bought of these inputs either declined or increased by less than the average rate. At the same time farmers purchased increased quantities of those inputs whose prices declined or increased by less than the average rate (with the exception of indebtedness charges). This analysis of the trends in prices of farm inputs and of quantities bought therefore supports the idea suggested at the beginning of this article, namely that farmers in Canada have substituted, and will continue to do so, the less expensive inputs for the more expensive, insofar as this is technically possible. This is an important means whereby the agricultural industry contributes to productivity gains or, in other words, to decreased real unit costs of production.

EXPLANATORY NOTES

1. The particular items of farm expenses included in the six major categories of expenses shown in the figure were the following;

Livestock: feed purchased through "commercial channels", *i.e.*, from non-farm sources, purchased feeder livestock (from non-farm sources). A.I. fees, livestock registration fees, veterinary expenses.

Machinery: farm share only of fuel, lubricants, machinery and motor vehicle repairs, tires, antifreeze, licences, insurance, etc.

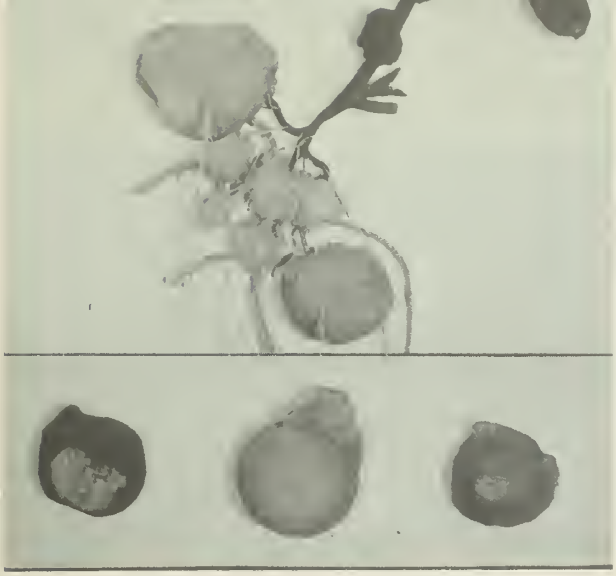
Real Estate: property taxes on "owned" land and buildings, cash and share rents, interest on indebtedness (real estate and chattels), building repairs.

Labor: wages to hired farm labor only.

Crop: fertilizers, limestone, pesticides, nursery stock, irrigation levies, containers, seed purchased from non-farm sources, twine.

Other: electricity, telephone, custom work, insurance other than for machinery, other supplies and services.

2. The current estimates of farm operating expenses were adjusted for price changes by means of an appropriate index of farm input prices, by years and by published items, to obtain estimates of quantities of inputs purchased. The particular references are given in the sources cited in the table above. ■



Models of potato plant and tubers display warted excrescences at eyes, collar and stem. The disease as it appears in root and stem growth is shown above; below, from left, are three of the more susceptible varieties: Arran Victory, Kerr's Pink and Irish Cobbler.

POTATO WART RESEARCH IN NEWFOUNDLAND

MICHAEL C. HAMPSON
and KENNETH G. PROUDFOOT

La galle verruqueuse de la Pomme de terre, largement répandue à Terre-Neuve, est une maladie insidieuse et destructive portée par le sol. L'interaction entre l'agent causal *(Synchytrium endobioticum)* et l'environnement est investiguée à divers niveaux. Ceci nous permet d'entrevoir de nouvelles approches de contrôle.

At the St. John's West Research Station we are investigating several phases of potato wart disease, or 'canker', *Synchytrium endobioticum.* This dangerous disease of potatoes is at present found in Canada only in Newfoundland where it was first discovered here in 1909. In a recent survey the disease was found to be widely distributed throughout the Island.

An increase in awareness and understanding of potato wart disease by Newfoundland farmers has led to an increase in control. The growing of immune varieties and the use of sanitation measures have helped to curb the incidence of the fungus that causes the wart, thereby reducing its spread among potatoes.

VARIETAL RESISTANCE

Let's have a closer look at resistance-breeding prospects. Prior to 1957 many European and American potato varieties were tested for their reactions to the disease. Few resistant varieties were discovered but two American varieties, Kennebec and Sebago, had a moderate level of resistance producing fewer than 1 in 100 warted tubers when grown in heavily infested soils. Even higher levels of resistance were found in the red skinned yellow fleshed Dutch varieties Ultimus and Urgenta, which usually remained free of wart infection. A few numbered selections from the National Potato Breeding Program at Fredericton were also highly resistant.

In addition to testing varieties, the distribution of the disease was established by a survey which showed that it was located predominantly in the eastern regions of the Island, the more densely populated and older settlements where potatoes have been monocultured in kitchen gardens for many decades. The more recently cleared areas were fairly free from wart infestation.

Crosses were made between the highly resistant varieties and susceptible varieties or selections which gave good yields under Newfoundland conditions. Relatively few crosses were made in the early years of the program and only small numbers of selections were tested annually. However, the program gradually expanded and at present about 100 crosses are made annually and 20,000 seedlings are raised each year. Many of these seedlings produce potatoes of poor commercial type but if the tuber proves resistant to wart, they may be important for use as parents in subsequent crossing.

PINK PEARL

To date one wart-resistant variety, Pink Pearl, has been released. This variety originated from a cross made in 1962 between the yellow-fleshed resistant variety Ultimus and the U.S. variety Katadhin. Pink Pearl has inherited its pink skin color from Ultimus

ED. NOTE: Black wart disease or "canker" of potatoes is known to exist in Newfoundland but not in other provinces of Canada. The spread of this disease from Newfoundland is prevented by the enforcement of the Plant Quarantine Regulations administered by the CDA's Plant Protection Division.

The authors specialize in plant diseases and plant breeding, respectively, at the CDA Research Station, St. John's West, Nfld.

In this growth room sequence of a warted potato plant, an infected shoot is enlarged to show the nature of the rapidly growing excrescence typical of the disease.

but has the white flesh of Katadhin. Yields and cooking quality of Pink Pearl have been variable, but it has excellent keeping qualities and, incidentally, has good levels of resistance to late blight and blackleg diseases. The variety was named in 1969 and considerable quantities of seed are now being produced.

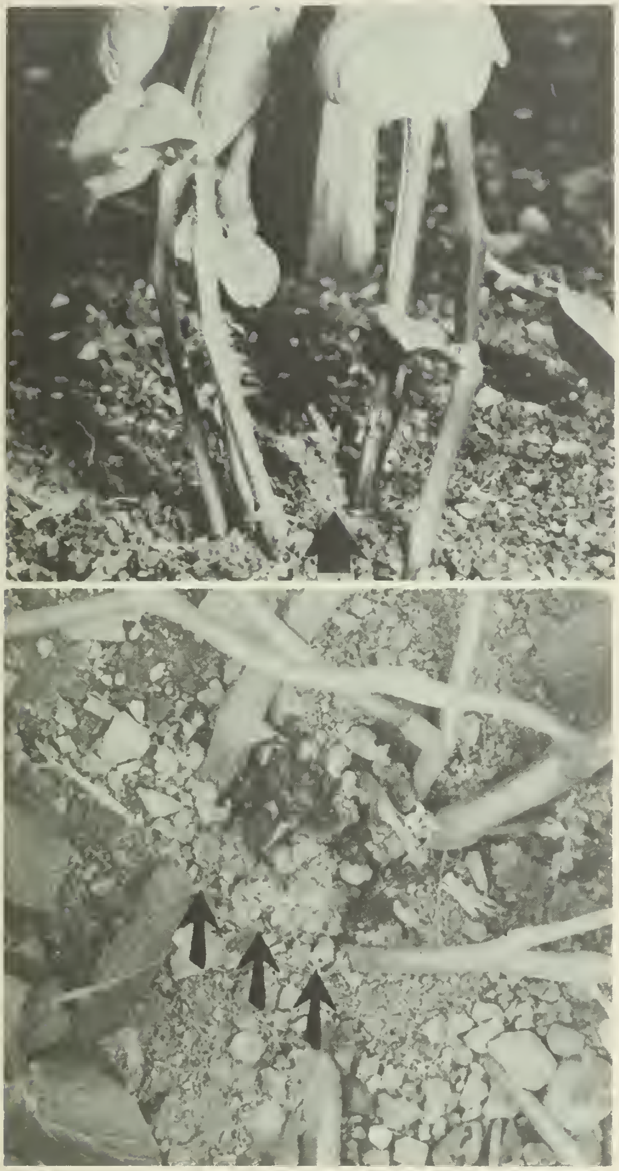
Another variety, Urgenta, was found to be resistant in our early tests and also yielded well. Despite its yellow flesh it has met with limited acceptance in some areas of the Province. Unfortunately, it is extremely susceptible to blackleg, which results in poor stands and poor storage life. We are now in the final stages of testing a selection from a cross made in 1963 between Urgenta and the U.S. selection X96-56 which has the wart resistance, flesh and skin characteristics of Urgenta yet appears to be quite blackleg-resistant. If current test results are satisfactory, the selection will be named and released in 1973. We have another selection at an advanced stage of testing, a cross between the German variety Mira and a Fredericton seedling, which is resistant to all strains of the wart fungus, has white skin and flesh and produces a high yield. We believe this variety will be widely accepted by commercial farmers throughout the Province.

ERADICATION

There is, apart from the control approach through breeding, another very important aspect of the disease to be concerned about. What is to be done about the wart fungus that is already in the soil and which may have been there for a great many years, even though the soil may not have been planted to potatoes for a long time? We know the wart fungus can remain at rest or be "dormant" for thirty years or more and still infect potato crops. We feel that dormant spores are probably the chief source of infestation. It means that soil and unwashed produce have to be restricted to localized areas and this introduces problems of quarantine and legislation. For this reason, vehicle washing equipment has been installed at the Port-aux-Basques ferry terminal for outgoing vehicles.

As part of the problem of eradication we must take into account the existence in the Province of more than one strain of the fungus. We know of three, and possibly four, strains which inhabit its soils. This is small compared with some countries' "boast" of twelve or more strains! But this is a factor which complicates our breeding program, too. It means that immune potato varieties must be bred which resist all our known strains, and at the same time be able to resist unknown strains which may have developed many years ago and remained dormant in the Province's soils.

In tackling the problem of potato wart eradication from the soil we are mindful of the fact that many outport residents annually produce their own potato crops from small kitchen-garden plots. It has been estimated that 94 percent of these kitchen gardens are wart-infested. The problem is to eradicate the wart fungus but not to destroy the soil's usefulness, as eradication programs in other parts of the world have done. The release of the fungal zoospores which enter the potatoes' susceptible infection courts (such as stolon tips, tuber sprouts), is the only stage of its life cycle that is weak and susceptible to attack by man. We therefore have to capitalize on this one fact in order to achieve economic eradication of the organism.



(Top) Cankered potato shoot (arrow) grows above soil surface in sporangia-infested soil. Note warty appearance of stems caused by sporangia in the surface cells.

(Bottom) Vertical view of badly-infected potato plant shows wart between the shoots causing them to blacken and decay.

GROWTH ROOM CONCEPT

To understand how we can increase the productivity of potato wart disease-infested soils we have developed a growth room at the Station in which we can grow potatoes under controlled conditions. The principle of operation is that outside air, cooler than the room air, is blown in through a pegboard plenum on one side, and the air heated by lamps in the room is exhausted through an identical pegboard plenum on the opposite side. Throughout the year an experimental test series is being carried out to determine ideal conditions for growth of different strains of the fungus in susceptible potato varieties. When the best conditions for disease development are known, we will be able to manipulate the growth chamber environment of the potato plant. The growth room concept puts six growing seasons into one year, and puts us in the position of being able to increase our knowledge of 'how' and 'why' in the eradication situation, as opposed to the plain 'what' of field experimentation. It permits us to concentrate more closely on the factors controlling disease development and we can more readily assess and compare the success of plant and soil treatments, without being dependent on the vagaries of the notoriously changeable Newfoundland weather.

CHEMICAL CONTROLS

One very promising line of attacking the disease would be to spray the potato plant with a non-toxic chemical which is absorbed by the plant, excreted by the root system and brings about the death of the infective zoospores released from the germinating resting sporangia. We find that water extracts of flesh, sprouts and stolon tips of potato varieties yield certain amino acids and that only the extracts of susceptible tissues cause the fungus to germinate in glass dishes. We are using such tools as chromatography and fluorescence microscopy to analyze the differences among our samples in an effort to identify a germinating component of the susceptible varieties. Another approach to control, therefore, is to add to the soil a chemical that causes the fungus to germinate without potatoes. The zoospores, not being able to find susceptible tissue to infect, will die. These methods could lead to a rapid death of the fungal population.

INTEGRATED ATTACK

The plan of attack to control the disease is based on the twin disciplines of plant breeding to develop immune germ plasm, and plant pathology to eradicate the fungus, aided by suitable legislation to prevent the movement of diseased potato stocks. We believe the final solution to the wart disease problem will only come from such an integrated approach and that this will take considerable time and resources. ■

ICE SHEET INJURY AND FORAGE CROPS

STUART N. EDEY

Les nappes de glace causent périodiquement d'importants dégâts aux plantes herbacées en hivernage. Des recherches portant sur la nature exacte des dégâts causés par les nappes de glace pourraient conduire à l'élaboration de techniques permettant de réduire les dégâts aux plantes et aux cultures subséquentes.

Canada's extremely variable weather has far-reaching effects on agriculture, often with adverse economic impact.

Although "normal weather" is rarely experienced, minor variations create no problems; extremes such as prolonged wet spells, floods, droughts, frost and ice storms, cause extensive crop damage and economic hardship.

Two extreme weather conditions combined during the 1972 crop year to create a serious financial situation for many farmers in Eastern Ontario and Western Quebec. Forage crops were particularly affected. A severe winter was followed by poor harvesting weather.

Ice sheets formed on the soil early in the winter and persisted through to late spring. The effect of ice sheets on the survival of forage plants is discussed here.

UNUSUAL WEATHER

As a rule, heavy snow during winter ensures maximum survival for over-wintering plants. For Eastern Ontario and Western Quebec, the 1971-72 winter season proved exceptional. Despite record snowfalls—in excess of 123 inches by the end of March—the 1972 forage crop prospects were the subject of considerable speculation.

An unusual sequence of weather events during the previous November and December 1971 ultimately proved critical to the 1972 forage crop. Ice sheet injury ranged from slight, on high well-drained fields, to a near-complete "kill" of legumes and grasses on low, newly-seeded fields.

The 1971-72 winter season had been unique in several respects: Snowfall during November was abnormally high—20.2 inches—compared with 6.4 inches for November 1970, and 7.1 inches for the long-term November average since 1890. During the second week of December '71, mild weather added a further 1.02 inches of rain, and melted the existing snow cover. The thaw resulted in the initial flooding of fields, and the stage was set. Two days of below-freezing temperatures caused ice sheet formation. The season's first frost penetration of the soil was extremely significant. It effectively sealed soil surfaces to the additional .55 inches of rain that fell Dec. 15. A very high proportion of ice-covered fields resulted.

With little snow during the next two weeks, there was further frost penetration. This precluded any possible thawing that would provide an all-important air space at the soil/plant/ice interface. Despite above-normal temperatures during the three-week "January thaw", and an all-time record maximum temperature of 40°F, Jan. 11, ice sheets remained intact and persisted well over a three-month period.

CAUSE AND EFFECT

How does all this relate to forage plants and the 1972 hay crop?

Winter injury and the survival of forage plants—particularly legumes—are influenced by disease, fluctuating temperature, and soil heaving. However, large-scale injury is primarily the result of three ad-

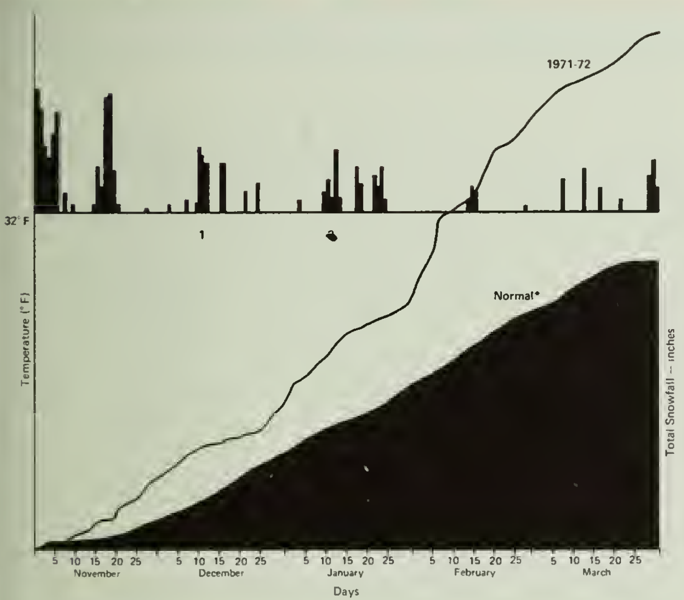
Mr. Edey is an Agroclimatologist with the Agrometeorology Section, CDA Plant Research Institute, Ottawa.

(Opposite page) Low oblique aerial photograph taken over eastern Ontario from an approximate altitude of 500 feet shows results of icesheeting damage to pasture on clay soil. In this black and white translation from infrared false color, lighter tones represent areas of high infrared reflection from vigorous growth; darker tones reflect sparse growth or bare soil conditions.

ditional factors operating singly or in combination: low temperature, desiccation and smothering. The latter caused most concern for the 1972 forage crop.

Smothering occurs when an ice sheet forms directly on the soil surface, causing portions of the overwintering plant to become sealed in a layer of ice. Injury results from the exclusion of oxygen or from the inability of the sealed plant tissue to avoid lethal concentrations of carbon dioxide—the by-products of root and crown respiration and of microbial activity in the soil. It has been observed that less hardy legumes have a higher degree of metabolic activity during winter dormancy than do the more hardy types which respire at a slower rate.

Although tolerance varies according to the type of forage plant involved, ice sheet duration can vitally affect crop survival. Forage grasses are considerably more tolerant than legumes (particularly alfalfa), to unfavourable wintering conditions. Independent studies have shown that alfalfa plants maintained in ice for periods up to 38 days will survive in a weakened state; after 50 days there is a high mortality rate. Varieties of bentgrass have survived up to 90 days in an ice sheet environment. In the 1972 situation, ice sheet duration was protracted well beyond known limits, thus, all forage plants faced hazardous survival prospects.



Daily climatological data for winter 1971-72. The graph shows maximum temperature above 32°F vs. accumulated snowfall from Nov. 1 to Mar. 31.

**Normal: 30-year period for 1936-65.*
[1]Period of thaw, Dec. 9-16; no snow on ground, Dec. 12-19.
[2]Period of thaw, Jan. 9-13; record maximum (47°F), Jan. 13.

REDUCED CROP LOSS

Although severe and widespread ice sheet injury to crops is sporadic, and limited to approximately one year in five, few years pass without some degree of ice sheet damage. Only the absence of frost in the ground throughout winter could preclude all ice sheet injury. In Canada, limited research of this phenomenon has been confined to laboratory conditions.

Research is needed to determine exactly how ice sheets cause plant injury, and to find ways of alleviating plant damage. Preventive means might include:

—the leaving of longer stubble or leaf in the field
—using dark-pigmented spray material to induce increased absorbtion by plants of incoming radiation
—increasing ice porosity through mechanical or chemical means
—improving soil drainage
—using ice-tolerant varieties and species of plants
—including cold-hardiness through chemicals and other means.

Only through combining determinate research with systematic analysis of weather records can agriculture in Canada become less vulnerable to climatic factors and the associated financial risks. ■

Monthly Comparative Climatological Data: CDA Ottawa

	Mean temperature (°F)		Precipitation (inches)					
			Snow		Rain		Total	
	1971-72	Average*	1971-72	Average*	1971-72	Average*	1971-72	Average*
Nov.	32.3	33.3	20.2	7.1	.36	2.00	2.06	2.71
Dec.	19.3	17.8	17.4	18.5	1.73	.97	3.07	2.79
Jan.	26.2	20.9	22.2	20.9	.36	.67	1.69	2.75
Feb.	18.8	22.6	43.1	19.1	.98	.49	4.02	2.38
Mar.	21.3	25.4	20.1	14.2	.74	1.16	3.17	2.58

*Long term average 1890-1965

PREDICTING AND CONTROLLING WHITE MOLD EPIDEMICS IN WHITE BEANS

Sclerotinia *infection of beans causes stem rotting, leaf wilting and dropping. Seeds stop growing and pods may become moldy. Diseased (right) and healthy (left) plants from the same crop are illustrated.*

JERRY H. HAAS and BART BOLWYN

Des expériences à la Station de recherches d'Agriculture Canada de Harrow, en Ontario, ont montré que les haricots blancs susceptibles d'être infestés de moisissure blanche présentent un feuillage dense et d'autres caractéristiques en commun. Les semis à faible densité et l'assolement ne peuvent résoudre le problème. On peut maintenant obtenir de bons résultats par pulvérisations d'insecticide.

The white (navy) bean is grown on more than 100,000 acres in southwestern Ontario. It is the most important cash crop on many farms. It returned an average of $115 per acre to farmers over the five years of 1967-71. This is high for a field crop.

Although white beans can be very profitable, they are difficult and risky to grow. Weather conditions are a critical factor at planting, flowering, and harvest times; diseases may severely reduce yield.

White mold, mildew, watery rot, sclerotinia wilt are names commonly used when referring to one important disease frequently found in beans. All types of beans are affected.

One-third of the white bean crop is infected in an average year. In 1972, conditions were especially favorable for white mold epidemics to develop and almost the entire crop was severely affected. Dead plants and rotting pods greatly reduced yield.

It is not possible to eradicate the mold. *Sclerotinia sclerotiorum*, the fungus that incites the disease, is found on more than 150 crops in North America, and is present throughout the moist temperate zone in the northern and southern hemispheres. The fungus can remain dormant in the soil for many years.

Dr. Haas is a plant pathologist at CDA Research Station, Harrow, Ont.; Dr. Bolwyn is a plant pathologist for the Ontario Ministry of Agriculture and Food at Ridgetown College of Agricultural Technology, Ridgetown, Ont.

It is not feasible to breed varieties resistant to the disease because no source of resistance is known.

JOINT PROJECT

In 1968, a cooperative project to develop a control procedure for white mold was begun by the Canada Department of Agriculture and the Ontario Ministry of Agriculture and Food. We wanted to find the combination of cultural conditions under which white mold most often develops. Also, we had to develop an optimum procedure for applying an effective fungicide.

For two years we studied cultural conditions by sampling 100 randomly selected fields; different locations were picked each year. Plants in certain areas of the field were examined for disease, weighed, and counted. Fertility and texture of the soil were measured by standard soil tests. Finally, growers provided information on crop rotation, fertilizer use, and other farming practices.

Fungicide sprays were put on commercial crops in the area where growers advised us that white mold had been a problem. Three different materials were applied using sprays directed at the plants from between the rows. One year we used an air-blast sprayer.

Surprisingly, almost as much white mold was found in the randomly selected crops as in the crops picked for the chemical control experiments. Because the fungicides were sprayed on carefully selected fields, we expected that most of them would have white mold. In 1969, 20 percent of the randomly picked and 25 percent of the chemical test crops had white mold. In 1970, we were only a little better in forecasting where the disease would appear; 44 percent of the random and 60 percent of the sprayed crops had the disease.

We had not foreseen this difficulty in predicting the occurrence of white mold. We knew that the desease developed late in the season when foliage remained wet for several days at a time. We expected

Disease must be predicted before full-bloom and before the rows "close in". The space between rows in the crop (above) are about to become too narrow to accommodate spraying machinery.

crops with dense canopies to have more disease. Fertilizers, especially nitrogen, should have increased canopy density and disease development.

ROTATION UNIMPORTANT

Because crop rotation is usually recommended to control white mold, we thought the disease would be more important where rotation was not practiced.

Some of these factors were not important influences on the presence of the disease. Fields that had produced repeated crops of beans had no more disease than fields that had grown no beans or other susceptible crop for at least three years. The application of nitrogen or manure and the nutrient status of the soil had no influence on the incidence of white mold. The use of nitrogen fertilizers on white beans was moderate and ranged from 0-90 pounds an acre.

Important cultural conditions were those that directly influenced moisture and humidity around the plants. We measured "canopy density" by taking the weight of each plant multiplied by the plant population per acre. White mold was much more frequent where canopy density was high.

Plant population alone was important in a way we had not expected. More disease was present where there were fewer plants per acre. The important factor in our measure of canopy density was the weight per plant. A low seeding rate did not lead to less disease because the bean plants "compensated" by growing more foliage per plant. The thinner planted rows were filled with thick plants. These dense plants trapped moisture and also trapped petals falling from the bean flowers. Petals are good food sources for the fungus.

PREVAILING WINDS

Another significant association between white mold and cultural practices was also related to moisture in the crop canopy. Crops planted in rows running north-south (N-S) had more disease than crops planted in east-west (E-W) rows. The prevailing winds in southwestern Ontario are west to southwest. They provide more rapid drying conditions for E-W crops. Also, sunlight penetrates better into an E-W row than into a N-S one.

There is one major difficulty in attempting to control the disease by manipulating cultural conditions only. Conditions conducive to disease development also increase yield. Big plants can support more pods and seeds than small plants. White mold is a disease of high yielding bean crops. Crops with the disease produced 18 percent more beans than the average crop without white mold. In our tests, the average yield of uninfected crops was 1,560 pounds, and of infected crops 1,830 pounds an acre. Obviously, chemical control would have increased yields substantially.

White mold was inhibited if the crop was sprayed *before* the disease appeared. The fungicide 'benomyl' was the best material we tested. To eliminate white mold from commercial crops, benomyl would have to be applied to every field. This is economically and biologically unwise. The spray would cost $15-20 an acre and return an average of only 25 cents an acre; many fields would be sprayed unnecessarily.

RECOMMENDATIONS

A means of predicting the occurrence of white mold is required. Some basis for this prediction is available from our research on important cultural conditions.

We recommend spraying white bean crops

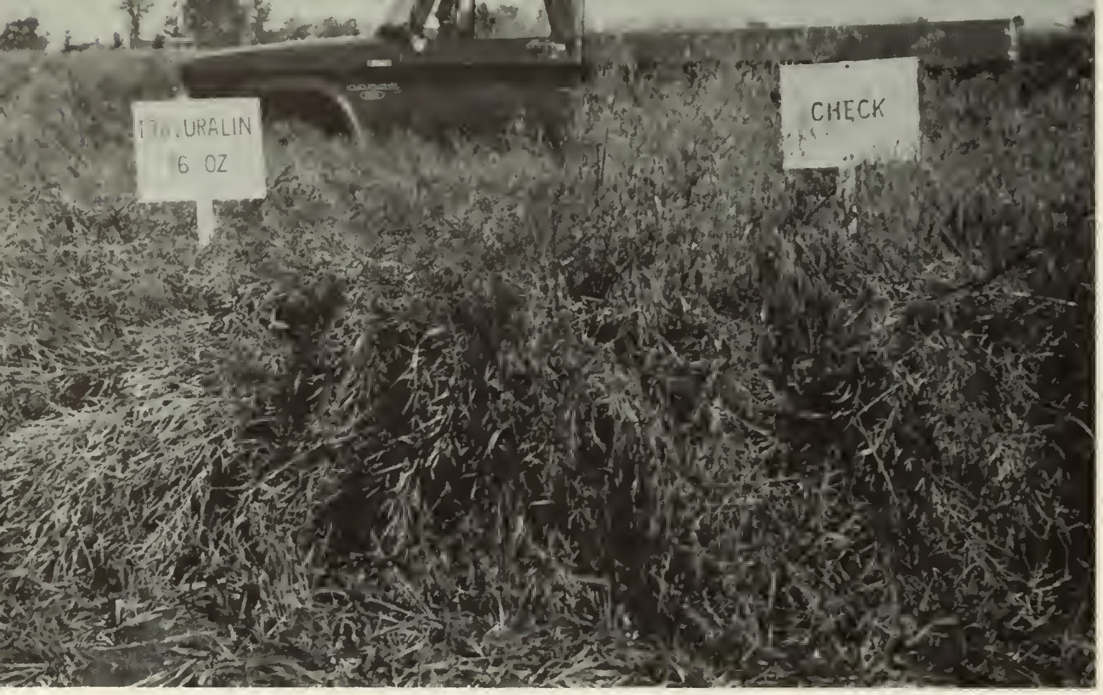
(1) growing in fields with a history of the problem, and

(2) with a heavy growth of foliage either late in July or early in August when the rows are about to "close in".

The spray must be directed at the base of the plants from between the rows. Spraying from above, even with an air-blast machine, is not effective. Although the fungicide is "systemic" it does not move from the leaves into the stem of the plant. Stem rotting is the most destructive phase of the disease in white beans.

The amount of the bean crop actually destroyed by white mold was estimated in our experiments, by combining the results of both phases of our study. In the chemical control test, yield was reduced by 13 percent when more than 40 percent of the plants in a field were infected. There was no effect below 40 percent infection. An average of 10 percent of the commercial crops examined had more than 40 percent white mold.

In 1972, more than 75 percent of the crop was infected to the 40 percent level. Estimated loss in an ordinary year is $250,000. In 1972, the loss was approximately 200 pounds an acre on 125,000 acres, with a dollar loss of at least $2 million. ■



Note the near complete elimination of wild oats in Treflan (trifluralin) treated plots in Lacombe Research Station field plot tests, 1972. Rain and high winds have caused lodging of the rapeseed.

TREFLAN CONTROLS WEEDS IN RAPESEED

H. A. FRIESEN

Bien que le colza soit une plante vigoureuse, les mauvaises herbes peuvent en abaisser considérablement le rendement et la qualité. On a découvert à la Station de recherches d'Agriculture Canada de Lacombe, en Alberta, que le Treflan était un bon désherbant qui ne cause pas de dégâts au colza ni aux cultures céréalières subséquentes.

Rapeseed, like its close relative wild mustard, is a vigorous plant and should be able to compete with weeds. However, weeds can and frequently do cause serious losses in yield and grade of this important crop. Although the damage caused by weeds may be less spectacular than a sporadic outbreak of bertha armyworm, weed losses occur annually and are more widespread, so the total damage is greater.

Wild oats are a major menace in the cooler Park Belt where most of the rapeseed is grown. This weed is capable of competing with strong stands of rapeseed, causing yield losses of up to 30 percent and dockage as high as 20 percent. Cleavers, another primary noxious weed, has become a problem in rape within recent years. When infested with cleaver seed, rapeseed crops are placed in the "rejected" grade. Because of its size, cleaver seed is difficult to remove from rapeseed. To date, the cleaver weed is of limited occurrence in Western Canada. However, consid-

Mr. Friesen is a weed control specialist and Head of the Crop Management and Soils Unit, CDA Research Station, Lacombe, Alta.

ering the circumstances, weed control in the field can be very important to the successful production of this crop.

ESTABLISH STRONG STAND

Rape requires a firm uniform seedbed, so that the seed can be sown to moisture at a depth of about one inch. This results in rapid emergence, and enables the crop to compete more effectively with weeds. Avoid loose or lumpy seedbeds. They dry quickly to the depth of cultivation, resulting in the disiccation and death of young seedlings. Establishment of a dense vigorous stand will also depend on choice of the correct variety, timely seeding, and proper fertilizer practices suited to conditions in the area. Unfortunately, weather and circumstances often combine to give weeds a break, so further control measures, such as herbicides, are needed.

TREFLAN (TRIFLURALIN)

Rapeseed is highly sensitive to 2, 4-D and MCPA, commonly used in cereal crops. It is even hazardous to use these materials a week before planting the crop. Rape is also sensitive to Banvel, Buctril M and Brominil M which are effective against buckwheat in cereal crops. Obviously, a herbicide must be found that will give more selective weed control in the rape crop.

Treflan, a soil incorporated herbicide that has been used commercially in cotton and soybeans, seems to possess the required properties. Preliminary testing at CDA Research Station, Lacombe, Alta., in 1966, showed that Polish rapeseed was tolerant to rates up to two pounds an acre. Further study revealed that acceptable control of wild oats, buckwheats, pigweeds, hemp nettle, chickweed, and green foxtail could be obtained with .75 to 1.0 pounds per acre. Our investigations also found that Treflan is partly tied up by soil organic matter, therefore the higher 1.0 pound per acre rate is needed on soils having over 4.5 percent organic matter content. The activity of this herbicide was not seriously reduced by dry surface soil. While our work was with the Polish varieties, subsequent work in other parts of Western Canada has shown that the Argentine varieties react similarly.

APPLICATION, SOIL INCORPORATION

Proper placement and incorporation in the soil are imperative for successful use of Treflan. Crop residues should be thoroughly mixed into the soil by discing, plowing, or by a period of summer fallow. Treflan is readily lost from the soil surface by photodecomposition and volatilization. Therefore, it is essential to incorporate it into the soil by discing, cultivation or ratory tillage directly after spraying. Preferably, the spray boom should be mounted in front of the tillage machine so that spraying and incorporation are performed at the same time. The tandem disc is the most commonly used implement for this operation on prairie farms. For best results, fields should be worked twice, with the second operation at right angles to the first (cross discing).

The herbicide should be added to the water during filling of the sprayer tank. The volume of water used in spraying is not critical but if low volumes of 10 gallons per acre or less are used the need for accurate calibration and uniform application increases.

Depth of incorporation is important for several reasons. First, Treflan does not move with soil moisture. Second, there is a diluting effect as incorporation depth increases. Third, shoot uptake is greater than root uptake; therefore, thorough uniform mixing in the surface two-to-three inches insures that all emerging shoots come in contact with treated soil. Since most weed seeds germinate in this soil layer, both shoot and root effects are realized. Fourth, rapeseed is small and must be planted at a shallow depth in a firm seedbed. The extra tillage needed to incorporate treflan tends to dry out the surface soil and may cause uneven crop emergence when a prolonged dry spell occurs after planting. This can be overcome by packing after tillage, or by applying the herbicide in the previous fall.

FALL, SPRING APPLICATION

Treflan is broken down by soil microorganisms. If it is applied when the soil is cool, *i.e.*, in October, before winter freeze-up, the loss is very small. However, increasing the rate by .25 pounds per acre is suggested as a precaution when the chemical is applied in the fall. The herbicide may be disced in twice directly after spraying in the fall, or be given one discing in the fall and a second in the spring as part of the seedbed preparation. Weed control results have been about equal with fall or spring applications. In a number of tests, rapeseed yield was greatly increased where fall application was used to avoid the excessive tillage of the soil needed with spring application and incorporation.

PERSISTENCE IN SOIL

Field experience and study have shown that Treflan provides season-long control of most of our troublesome broad leaf and grassy weeds in rape. Furthermore, there is no evidence of injury to sensitive crops planted in the year following use of the herbicide. Biological and chemical analyses of treated soil have confirmed the results observed in field investigations.

In summary, Treflan, applied before planting and immediately mixed into the surface two-to-three inches of soil, controls most weed species without injury to rapeseed. Residues harmful to succeeding sensitive cereal crops have not been observed. ■

Fig. 1. Preliminary evaluation of forages in a stress wheel design quickly reveals poor stand development, winter damage, as well as, leafy pasture types and potential hay selections.

SELECTING PRODUCTIVE HAY MIXTURES

A. T. H. GROSS

Le foin est la source énergétique de base des troupeaux de bovins de boucherie pendant une période de 7 à 8 mois l'an au Manitoba. Un simple mélange de deux cultures fourragères s'est révélé beaucoup plus nutritif, économique et rentable. La meilleure combinaison s'obtient en mélangeant une graminée avec une légumineuse.

Hay is the basic energy source for maintenance of beef herds in Manitoba for seven or eight months of the year. With growing consumer demand for more and better beef it is evident that more and better hay must be produced.

Cultivated hay acreage was 1.2 million acres in Manitoba in 1971. This was an increase of 20 percent over the 1961 acreage and 300 percent over that of 1951. There was a corresponding trend in livestock in the province.

Hay is usually a perennial crop made up of two or more forages in a mixture. A simple mixture of two forages is generally more productive, more nutritious and more economic than either a single forage or a complex mixture of several forages. The most satisfactory combination includes a grass with a legume.

The prime requisite in selecting forages for hay mixtures is that the forage crops be adapted to that type of production and harvesting. At Brandon Research Station we have screened many grasses and legumes but only 30 are recommended for forage production in Manitoba. Many forages fail to establish a thick stand. The few clumps that develop are inadequate for production or soil conservation. Some cultivars that establish themselves satisfactorily are subsequently injured or killed in winter and are therefore not adapted to our conditions. Perennial ryegrass and orchard grass are examples of forages that are damaged in winter in Manitoba.

All forages are not suitable for hay production. Seven of the 30 forages recommended in Manitoba are too short for hay. A large proportion of the crop cannot be cut and picked up as hay. Such forages are more satisfactory for pasture or seed production. Crops adapted to grazing but not recommended for hay are creeping red fescue, meadow fescue, Russian wild ryegrass, red clover and birdsfoot trefoil.

Mr. Gross is a forage crop specialist, CDA Research Station, Brandon, Man.

To be ideal, the components of a hay mixture should have similar seasonal growth patterns. This will result in an optimum yield of high quality. The combination of an early developing grass with a late developing legume will probably result in the grass suppressing the growth of the legume. There is also the problem of deciding whether to cut the hay when either the grass or the legume is at its peak, or to compromise and make hay when neither is at its best. We have found that crested wheatgrass presents problems as hay, since it is earlier than any of the adapted legumes and is past its best when the legume is ready to cut. It poses a further problem because of its tendency to remain almost dormant during mid-season, therefore contributing very little to the second cutting of hay in the fall. However, on some of our soils that warm up early in the season, a crested wheatgrass-alfalfa mixture produces good hay. Two cuts are sometimes possible.

Combinations of three or more forages in one hay mixture are difficult to maintain. Our studies show that one grass and one legume become the dominant forages after only one or two seasons. Yields from multiple mixtures are equal to or lower than those from simple mixtures of one grass and one legume.

Alfalfa is the only legume recommended for hay production in grass-legume mixtures. Other legumes are included in our studies but none of them has been satisfactory under the management systems used. However, current studies include different systems of plant geometry and fertility inputs in an attempt to broaden the spectrum of grass-legume mixtures that can be recommended.

Under our two-cut hay system, the second cut is predominantly alfalfa. The grasses do not recover as quickly as alfalfa during the high temperature period between the first and second cut. Selections of a restricted-creeping type of bromegrass give promise of developing better regrowth for a second-cut than the present varieties. In addition, some of the selections have shown less competition with alfalfa, thus providing a better grass-legume balance for hay production over a period of five years or more.

A few adapted forages have proved useful in Manitoba. Some have broad application and some have restricted specific use. However, to meet the hay production requirements resulting from the growing demand for beef, we need more selection of forage combinations and more detailed study of management systems. ■

Open grain pile on ground with hot spot near top center on Saskatchewan farm, October 1970. The grain was spoiled by caking, molds and heavy infestation by rusty grain beetle. Circular metal and wooden granaries are seen in the background.

R. N. SINHA

D'après une ètude des problèmes de stockage des céréales, menée par la Station de recherche d'Agriculture Canada de Winnipeg, au Manitoba, la production céréalière de 1970-1971 des trois provinces des Prairies était fortement infestée d'insectes et d'acariens. La Station de recherche de Winnipeg recommande que des recherches soient entreprises afin de déterminer quel serait le type de grenier à céréales et à oléagineux qui conviendrait le mieux aux Prairies.

A LOOK AT GRAIN STORAGE PROBLEMS

Before 1929 grain storage was not considered a problem because grain could be marketed without large carryovers. During the Second World War large quantities of dry grain had to be stored for the first time in Canadian history. Emergency storage facilities were built near terminal and country elevator points throughout the Prairie Provinces to hold grain from one to four years. Severe problems were created, particularly by tough grain in flat storages, and by heating and spoilage because of mold, insects and mites. The rusty grain beetle emerged as the major pest of stored grain. But after the war the emergency grain storage problem disappeared abruptly when grain stocks were exported to help alleviate the world shortage of food.

Since then, we have had two other crisis periods. In addition, wet harvests in 1951 and 1968, the introduction of a quota system for farmers, sluggish grain

Dr. Sinha is the insect ecologist at CDA Research Station, Winnipeg, Man.

sales abroad, and inadequate storage facilities on farms, have all contributed to grain storage problems.

Surveys showed a 13-fold increase in grain storage problems between the 1967-68 and 1968-69 crop years. In all three Prairie provinces these increases were obviously due to poor harvesting conditions and improper storage practices.

The most recent survey (1970-71 crop year), conducted as part of a long-term project on ecology and grain storage, was broadened somewhat to include health, engineering and communication topics.

A questionnaire prepared by the CDA Research Station, Winnipeg, was circulated by the country elevator divisions of 10 major grain companies in all 41 crop districts in the Prairie Provinces to their respective country elevator managers. Signed questionnaires from 2,919 elevator managers who replied were transferred to computer cards and analyzed at the University of Manitoba. Because the questionnaires were filled by the people most qualified to know about grain stored both on farms and country elevators, the results should be fairly representative of the actual situation.

Some of the major findings for the 1970-71 crop year in the Prairie Provinces are given below:

INFESTATION

A total of 11,618 insect and mite infestations was reported from farms and 1,197 from elevator premises. Farm infestations occurred in the areas served by 42 percent of the elevators; 15 percent of all elevators were infested. Generally, Manitoba had more of these problems than the other two Prairie Provinces.

A total of 6,805 rusty grain beetle infestations was reported from farms and 822 from elevator premises. Farm infestations occurred in the areas served by 37 percent of the country elevators; 11 percent of all elevators were infested. Manitoba also had more problems than other Prairie Provinces.

A total of 11,289 cases of hot spots occurred on farms and 929 in elevator premises. Grain heating on farms occurred in the areas served by 52 percent of the elevators; 17 percent of all elevators had hot spots in stored grain. Generally Alberta had more hot spot problems than Manitoba and Saskatchewan.

A total of 12,956 cases of moldy grain bulks was reported from farms and 570 from elevator premises. Farm infestations occurred in areas served by 49 percent of the elevators; only nine percent of all elevators experienced moldy grain problems. All three Prairie Provinces had the same level of problems.

Pesticides were used 6,313 times to control insect pests in stored grain on farms, and 672 times in elevator premises. Pesticides were used on farms in areas served by 34 percent of the elevators; only 12 percent of elevators used pesticides. Pesticide usage in stored grain was the highest in Manitoba.

A damp-grain hot spot with moldy and caking grain mass, discovered in a 12,000-bushel grain bulk on a Manitoba farm, April 1969. A face mask provides some protection from molds harmful to human health.

PESTICIDES AND PRECAUTIONS

Of the 2,919 elevator managers who replied, 860 (29 percent) considered Phostoxin as the most commonly used pesticide, 462 (16 percent) Malathion, and 53 (two percent) EB-5. Their second and other choices varied. Phostoxin was the most popular pesticide used in Manitoba; Malathion was most common in Alberta. Only 23 percent reported that adequate precautions (use of gas masks, etc.) were taken during application of pesticides on farms and in elevators, eight percent said that no precaution was used; 70 percent did not know.

HEALTH PROBLEMS

Three percent of the elevator managers in our poll reported that people were sick due to use of fumigants in stored grain.

Eighteen percent of the elevator managers in our poll were allergic to dust, 22 percent to moldy grain, two percent to household dust and four percent to other materials. These percentage figures were similar for managers from all three Prairie Provinces.

Sixty-seven percent of the elevator managers used dust masks when working with moldy grain, 33 percent used masks when working with all grains. Largest number of managers using dust masks were from Saskatchewan.

DETECTION DEVICES

Sixty-seven percent of elevator managers in our poll reported the metal rods were used in grain bulks on farms to detect heating of stored grain; 31 percent reported that metal rods were used in elevator bins. Manitoba elevator managers made the most use of this early spoilage detection device.

Only seven percent of the elevator managers reported use of insect traps (perforated rod type) to detect infestation by insects in farm stored grain; four percent reported using the trap in elevator bins.

OPEN GRAIN PILES AND FARM GRANARIES

Of the 2,919 elevator managers who replied, nine percent reported many open piles on farms in their area; 66 percent reported a few piles, and 26 percent reported none. Manitoba had fewer open grain piles than any other province.

Thirty-six percent of the elevator managers in our poll thought that circular metal bins on farms contribute most to grain storage problems; 26 percent thought wooden bins; 14 percent thought machine sheds; and 20 percent thought other types of bins are causing spoilage problems.

Elevator managers in all the three provinces felt that circular metal bins cause more storage problems than any other type of bin.

TECHNICAL INFORMATION

Seventy-five percent of elevator managers thought the farmers' primary source of technical information was the elevator manager; 18 percent thought the primary source was the provincial agricultural representative (or the district agriculturist); three percent thought various companies; and three percent thought miscellaneous sources. Agricultural representatives in Manitoba were used more often as the primary source of information than their counterparts in any other province.

According to 46 percent of the elevator managers the agricultural representative was the farmers secondary source of information.

Sixty-five percent of the elevator managers in our poll felt that enough information was available to have averted the "bettle" problem we had in 1970 with our overseas customers; 35 percent thought that such information was unavailable.

Ninety percent of elevator managers in our poll reported that their own companies were the primary source of technical information which they pass on to farmers. The federal government, according to 26 percent of the elevator managers, was the most important secondary source of such information; other secondary sources were agricultural representatives (21 percent), provincial government (17 percent), meetings and courses (six percent), other farmers (four percent), manufacturers (three percent).

Farmers' demand for agro-information from their elevator managers was greatest during the winter in all three Prairie Provinces. The largest volume of enquiries—more than 20 per season—occur in the fall.

RECOMMENDATIONS

The level of infestation of elevator premises by the rusty grain beetle, other insects and mites ranged from 10 to 15 percent. Efforts should be made to lower infestation, preferably to a one-to-five percent level. All agencies involved in grain storage and transportation should cooperate in their efforts to keep the pests below a five percent level all year round.

The level of infestation of farmers' grain ranged from 37 to 42 percent. In one province it was as high as 57 percent. Through educational programs, research on farm problems, and other methods, we should try to lower this level to 10 percent.

If another damp harvest occurs, well-planned drying and storing programs, combined with educational information, should be initiated at the time of initial grain storage on farms.

Farmers and grain companies should follow uniform recommendations for the type of pesticides to be used, granary structures to be built in harmony with our climate, and safety procedures (such as, gas masks and dust masks) to be used. The current trend to use Malathion as a grain protectant is a good one.

All managers and farmers should be advised to use properly tested dust masks during loading and unloading of grain.

More elevator managers and farmers should be encouraged to use cheap grain-spoilage detection devices, such as metal rods for hot spots, and perforated rod-type traps for insects.

Research should be undertaken by university and federal laboratories to determine which type of granary has the best keeping quality for grain and oilseeds stored under Prairie conditions. Large scale buying of circular metal bins (particularly the over-3,000 bu. capacity) for grain storage without prior testing should be discouraged. Manufacturers should be asked to provide grain storage stability data when large metal bins are sold.

Information on technical know-how should be given in a more coordinated and balanced fashion. ■

INFORMATION
Edifice Sir John Carling Building
930 Carling Avenue
Ottawa, Ontario
K1A 0C7

Canada Post Postage paid
Postes Canada Port payé
Third class Troisième classe
K1A 0C5
Ottawa

IF UNDELIVERED, RETURN TO SENDER EN CAS DE NON-LIVRAISON, RETOURNER À L'EXPÉDITEUR

Agriculture Canada

© Information Canada, Ottawa, 1973